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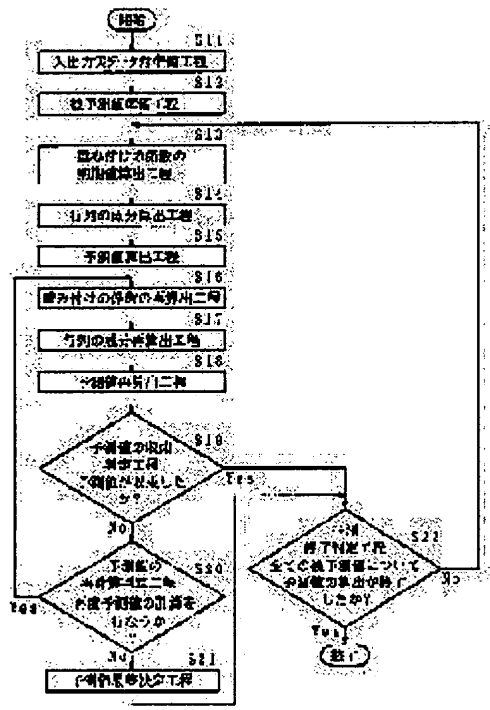
(54) METHOD FOR PREDICTING COLOR TRANSFER CHARACTERISTIC

(57)Abstract:
PROBLEM TO BE SOLVED: To predict a color transfer characteristic by processing statistically real data of input/output of a color input/output device, that is, to predict an output signal with respect to an optional input signal and to predict an input signal with respect to an optional output signal, or to predict remaining part of the input signal from part of the input signal and an optional output signal.
SOLUTION: Input/output real data pair are prepared (S11) and a predicted value is prepared in the S12. An initial value of a weight coefficient is calculated (S13) by using the data, and a component of a matrix and a predicted value are calculated so that a square sum of Euclid distance sets weighted by a weighting coefficient between an output prediction value and a plurality of output real data corresponding to the prediction value is minimized (S14, 15). The weighting coefficient is calculated again by using them (S16), and similarly the component of the matrix and the predicted value are obtained (S18). The processing above is repeated and the weighting coefficient, the component of the matrix and the prediction value are decided.



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CLAIMS

[Claim(s)]
[Claim 1] It connects with a matrix so that it may become the linear relation characterized by providing the following. The component of this matrix is determined that the square sum of the value which carried out weighting to the difference for every signal component of the output forecast calculated using this matrix and two or more output live data corresponding to it by the coefficient of weighting of forecast-ed dependence will become the minimum from the live data of two or more input signals. The color transfer-characteristics prediction method characterized by calculating an output forecast using this matrix from the input signal which is a forecast-ed Live data of two or more input signals of a color picture input unit or a color picture output unit It sets to the color transfer-characteristics prediction method of asking for the output signal which is a forecast corresponding to the arbitrary input signals which are forecasts-ed from the data pair of the live data of the output signal corresponding to it, and is a constant term about the relation between an input signal and an output signal.
[Claim 2] the input space standardized when the coefficient of the aforementioned weighting divided the difference for every signal component with the live data of the input signal of a forecast-ed, and an input signal by the constant for every input signal component -- difference -- the color transfer-characteristics prediction method according to claim 1 characterized by being the monotonically decreasing function of the Euclidean distance in the standardization input signal space for which it asks from a component
[Claim 3] the input space standardized when the coefficient of the aforementioned weighting divided the difference for every signal component with the live data of the input signal of a forecast-ed, and an input signal by the constant for every input signal component -- difference -- with the monotonically decreasing function of the Euclidean distance in the standardization input signal space for which it asks from a component The color transfer-characteristics prediction method according to claim 1 characterized by consisting of data precision functions calculated from the interrelation of the output forecast beforehand predicted to the live data of each input signal, and the live data of an output signal.
[Claim 4] It connects with a matrix so that it may become the linear relation characterized by providing the following. So that the square sum of the value which carried out weighting to the difference for every signal component of the output forecast calculated using this matrix and two or more output live data corresponding to it by the coefficient of weighting of forecast-ed dependence and component dependence of this matrix may become the minimum from the live data of two or more input signals The color transfer-characteristics prediction method characterized by determining the component of this matrix, the coefficient of weighting, and a forecast with the successive approximation method Live data of two or more input signals of a color picture input unit or a color picture output unit It sets to the color transfer-characteristics prediction method of asking for the output signal which is a forecast corresponding to the arbitrary input signals which are forecasts-ed from the data pair of the live data of the output signal corresponding to it, and is a constant term about the relation between an input signal and an output signal.
[Claim 5] the input space standardized when the coefficient of the aforementioned weighting divided the difference for every signal component with the live data of the input signal of a forecast-ed, and an input signal by the constant for every input signal component -- difference -- with the 1st monotonically decreasing function of the Euclidean distance in the standardization input signal space for which it asks from a component By dividing by the constant for every signal component, after changing into the component of the output space which considered sensitivity using the component of this matrix by the difference for every signal component with the live data of the input signal of a forecast-ed, and an input signal The color transfer-characteristics prediction method according to claim 4 characterized by consisting of the 2nd monotonically decreasing function of the Euclidean distance in the standardization output signal space for which it standardizes and asks.
[Claim 6] the input space standardized when the coefficient of the aforementioned weighting divided the difference for every signal component with the live data of the input signal of a forecast-ed, and an input signal by the constant for

every input signal component -- difference -- with the 1st monotonically decreasing function of the Euclidean distance in the standardization input signal space for which it asks from a component The 2nd monotonically decreasing function of the Euclidean distance in the standardization output signal space for which it standardizes and asks by dividing by the constant for every signal component after changing into the component of the output space which considered sensitivity using the component of this matrix by the difference for every signal component with the live data of the input signal of a forecast-ed, and an input signal, The color transfer-characteristics prediction method according to claim 4 characterized by consisting of data precision functions calculated from the interrelation of the output forecast beforehand predicted to the live data of each input signal, and the live data of an output signal.

[Claim 7] The color transfer-characteristics prediction method characterized by to determine the component of this matrix, the coefficient of weighting, and a forecast with the successive approximation method so that the square sum of the value which is characterized by to provide the following, and which carried out weighting to the difference for every signal component of the output forecast which tied up with the matrix so that it might become linear relation, and was calculated using this matrix from the live data of two or more input signals, and two or more output live data corresponding to it by the coefficient of weighting of forecast dependence at least may become the minimum Live data of two or more input signals of a color picture input unit or a color picture output unit It sets to the color transfer-characteristics prediction method of searching for a part of input signals which are a forecast corresponding to the arbitrary output signals which are forecasts-ed or arbitrary output signals which are forecasts-ed, and remaining input signals which are the forecasts corresponding to a part of input signal from the data pair of the live data of the output signal corresponding to it, and is a constant term about the relation between an input signal and an output signal.

[Claim 8] the input space standardized when the coefficient of the aforementioned weighting divided the difference for every signal component with the live data of the input signal of a forecast, and an input signal by the constant for every input signal component -- difference -- the color transfer-characteristics prediction method according to claim 7 characterized by being the monotonically decreasing function of the Euclidean distance in the standardization input signal space for which it asks from a component

[Claim 9] the input space standardized when the coefficient of the aforementioned weighting divided the difference for every signal component with the live data of the input signal of a forecast, and an input signal by the constant for every input signal component -- difference -- with the monotonically decreasing function of the Euclidean distance in the standardization input signal space for which it asks from a component The color transfer-characteristics prediction method according to claim 7 characterized by consisting of data precision functions calculated from the interrelation of the output forecast beforehand predicted to the live data of each input signal, and the live data of an output signal.

[Claim 10] the input space standardized when the coefficient of the aforementioned weighting divided the difference for every signal component with the live data of the input signal of a forecast, and an input signal by the constant for every input signal component -- difference -- with the 1st monotonically decreasing function of the Euclidean distance in the standardization input signal space for which it asks from a component By dividing by the constant for every signal component, after changing into the component of the output space which considered sensitivity using the component of this matrix by the difference for every signal component with the live data of the input signal of a forecast, and an input signal The color transfer-characteristics prediction method according to claim 7 characterized by consisting of the 2nd monotonically decreasing function of the Euclidean distance in the standardization output signal space for which it standardizes and asks.

[Claim 11] the input space standardized when the coefficient of the aforementioned weighting divided the difference for every signal component with the live data of the input signal of a forecast, and an input signal by the constant for every input signal component -- difference -- with the 1st monotonically decreasing function of the Euclidean distance in the standardization input signal space for which it asks from a component The 2nd monotonically decreasing function of the Euclidean distance in the standardization output signal space for which it standardizes and asks by dividing by the constant for every signal component after changing into the component of the output space which considered sensitivity using the component of this matrix by the difference for every signal component with the live data of the input signal of a forecast, and an input signal, The color transfer-characteristics prediction method according to claim 7 characterized by consisting of data precision functions calculated from the interrelation of the output forecast beforehand predicted to the live data of each input signal, and the live data of an output signal.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention reads a color manuscript, performs an image processing, and relates to the color transfer-characteristics prediction method of color picture I/O devices, such as the scanner and printer which are used in case the color processing coefficient of the various image processing systems performed in order to obtain the color reproduction which wishes for a manuscript picture in the digital full color copying machine reproduced on a record medium-ed, color facsimile, a color system, etc. is determined, and a display.
[0002]
[Description of the Prior Art] For example, after reading a manuscript with a scanner, performing the image processing changed into the signal of the color space independent of equipment from the signal of the RGB color space which is the output of a scanner and carrying out a certain edit processing, the image processing changed into the signal of the CMYK color space which is the input of a printer is performed, and a system which carries out a printed output by the printer is assumed. In this case, from the signal of the RGB color space depending on the equipment which is the output of a scanner, performing the image processing changed into the signal of the color space independent of equipment will grasp correctly the relation between the color of an input of a scanner, and the color of the RGB color space of the output of a scanner, i.e., the color transfer characteristics of an input unit, and it will perform the reverse image processing. Performing the image processing which similarly is changed into the signal of the CMYK color space depending on the equipment which is the input of a printer from the signal of the color space independent of equipment will grasp correctly the relation between the color in the CMYK color space of an input of a printer, and the color of the output of a printer, i.e., the color transfer characteristics of an output unit, and it will perform the reverse image processing. Even if an output unit is a display, the same thing can say.
[0003] It is foundations to grasp the property of equipment correctly, although the methods of deciding the color processing coefficient used in an actual image processing differ by how a difference of an image-processing method and the color reproduction to wish are set up, and if the output signal to the arbitrary input signals of a color-picture input unit is predicted or there is a method which has predicted the input signal over arbitrary output signals enough, and can do it, it will become easy to decide the color processing coefficient of an image processing.
[0004] There are what predicts the physical property of an I/O device as the color transfer-characteristics prediction method of a color I/O device using the physical model grasped and modeled, and the method of processing the live data of I/O of equipment statistically and predicting them.
[0005] For example, in JP,5-18305,B, it predicted by having assumed the physical model called noy violence UA equation in 3x3 matrices in the printer which is an output unit in the color scanner which is an input unit, and the technique of asking for a masking parameter by convergence calculation is proposed. However, even if, as for such a physical model, model precision determines the color processing coefficient of an actual I/O device well, what can be equal to practical use is not obtained. Moreover, development of a physical model with more high predictability had the problem that it was necessary to devise a model for every equipment of the, when the kinds of equipment differed, though it is difficult and development of a model was completed.
[0006] On the other hand, between I/O of a printer, the method currently generally called computer color matching assumes a high order polynomial or the function corresponding to the physical property of equipment, determines the coefficient of a function from the data pair of the live data of two or more input signals, and the live data of the output signal corresponding to it, and predicts the input signal over arbitrary output signals by solving the function asymptotically. However, predictability was influenced from the relation of the configuration of a function depending on how to take live data and equipment, and when it was the high order polynomial which requires machine time, there was a problem of being able to extrapolate outside of the color space of live data and being unable to predict it.

[0007] Moreover, from the data pair of the live data of two or more input signals, and the live data of the output signal corresponding to it, using the neural network, to P.125-129, the output signal to arbitrary input signals is predicted, or the method of predicting the input signal over arbitrary output signals is proposed in 2 or "high precision printer model by high precision color conversion-neural network by flexible GCR -", Society of Electrophotography of Japan, Vol.35, and No. 1996. [besides JP,7-87347,A and Murai] By this method, when study took time too much or the outside of the color space of live data was extrapolated and predicted as well as use of a polynomial, there was a problem that it could not be used.

[0008] Moreover, in JP,2-226870,A, from the data pair of the live data of two or more input signals, and the live data of the output signal corresponding to it, after interpolation increases the number of data pairs, when an I/O signal is three dimensions, 3 local **** space of I/O is tied up with an alignment matrix, and the method of predicting the input signal over arbitrary output signals is proposed. By this method, since the smoothing feature of data is not contained, when the live data of an I/O signal contain a noise, it cannot be coped with. Moreover, this method is the technique which can be used when the dimension of an input and an output is the same dimension, and, in the case of three dimensions as which an output expresses a color in four dimensions [like YMCK] whose input is, cannot cope with it. Furthermore, when the outside of the color space of live data was extrapolated and predicted, there was also a problem that it could not be used.

[0009] Moreover, on the U.S. Pat. No. 5471324 specifications, after simple interpolation increases the number of data pairs from the data pair of the live data of two or more input signals of a printer, and the live data of the output signal corresponding to it, the method of deciding the coefficient of the conversion look-up table for printers is proposed by predicting an input signal from an output signal by weighting average. However, this method also had the almost same problem as above-mentioned JP,2-226870,A.

[0010] Moreover, the method of determining the coefficient of color processing as JP,2-289367,A using the technique guessed are statistical from the data pair of the live data of two or more input signals and the live data of the output signal corresponding to it is proposed. However, it is expected that there is a problem that the continuity of the forecast in the boundary of a subspace is not secured though description of interpolating and concreteness being missing only by being described by the language of **, and there being the same problem as above-mentioned JP,2-226870,A, or dividing into a subspace to the smoothing feature which divides the content into a subspace and which is made to correlate is contained.

[0011]

[Problem(s) to be Solved by the Invention] How to have made this invention in view of the situation mentioned above, process the live data of I/O of a color I/O device statistically, and predict color transfer characteristics, Namely, the method of predicting the output signal to arbitrary input signals and the method of predicting the input signal over arbitrary output signals, Or it aims at offering a method with the following features in a concrete form as a method of predicting a part of remaining input signals from a part of arbitrary output signal and input signal.

1. It is a method independent of the kind (physical characteristic) of equipment.
2. It is the method which has a smoothing feature on the assumption that the live data of I/O contain the noise.
3. Even when the dimension of an input signal is four dimensions, treat on a par with the case of three dimensions.
4. Predictability is high.
5. The continuity of a forecast should be secured.
6. There needs to be extrapolation capacity.
7. As compared with the method using the conventional neural network, the time of prediction is short.

[0012]

[Means for Solving the Problem] this invention ties up the relation between the input signal of a color picture input unit or a color picture output unit, and an output signal with a matrix so that it may become the linear relation containing a constant term, and it determines the component of this matrix from the data pair of the live data of two or more input signals, and the live data of the output signal corresponding to it. At this time, an input signal is made into a forecast-ed, an output signal is made into a forecast, and the component of a matrix can be determined if it is made for the square sum of the output forecast calculated using the matrix from the live data of an input signal and the value which carried out weighting to the difference for every signal component with two or more output live data corresponding to it by the coefficient of weighting of forecast-ed dependence to become the minimum. Moreover, what is necessary is just to determine the component of a matrix, the coefficient of weighting, and a forecast with the successive approximation method so that the square sum of the value which carried out weighting to the difference for every signal component of an output forecast and output live data by the coefficient of weighting may become the minimum in using the coefficient of component dependence of a matrix with forecast-ed dependence as a coefficient of weighting.

[0013] An output signal is made into a forecast-ed and an input signal is made into a forecast. an output signal and some

input signals Or a forecast-ed, So that the square sum of the value which made the remaining input signals the forecast and carried out weighting to the difference for every signal component of the output forecast calculated using this matrix from the live data of an input signal and two or more output live data corresponding to it by the coefficient of weighting of forecast dependence may become the minimum The component of a matrix, the coefficient of weighting, and a forecast can be determined with the successive approximation method. In this case, you may use the coefficient of component dependence of a matrix with forecast-ed dependence as a coefficient of weighting.

[0014] Moreover, in any case, you may raise precision, using as a component the data precision function calculated from the interrelation of the output forecast beforehand predicted to the live data of each input signal as a coefficient of weighting, and the live data of an output signal.

[0015]

[Embodiments of the Invention] About the gestalt of operation of the 1st of the color transfer-characteristics prediction method of this invention, general explanation is performed first. Although an input signal explains here using (7) formulas from (1) formula which takes for an example the case where an output signal is three dimensions in-dimensional [3] or four dimensions, and is shown below, it is limited to these, and does not divide and come out, and other number of dimensions of the number of dimension of an I/O signal are the same. (1) By three dimensions, as for a formula and (6) formulas, the output signal corresponds, when an input signal is three dimensions, (2) formulas and (7) formulas correspond, when an input signal is four dimensions, and in both cases, (3) formulas correspond.

[0016]

[Equation 1]

$$\begin{pmatrix} y'_{1i} \\ y'_{2i} \\ y'_{3i} \end{pmatrix} = \begin{pmatrix} m_{11} & m_{12} & m_{13} & m_{14} \\ m_{21} & m_{22} & m_{23} & m_{24} \\ m_{31} & m_{32} & m_{33} & m_{34} \end{pmatrix} \begin{pmatrix} x_{1i} \\ x_{2i} \\ x_{3i} \\ 1 \end{pmatrix} \qquad (1)$$

$$\text{但し、} i = 1 \sim n$$

$$\begin{pmatrix} y'_{1i} \\ y'_{2i} \\ y'_{3i} \end{pmatrix} = \begin{pmatrix} m_{11} & m_{12} & m_{13} & m_{14} & m_{15} \\ m_{21} & m_{22} & m_{23} & m_{24} & m_{25} \\ m_{31} & m_{32} & m_{33} & m_{34} & m_{35} \end{pmatrix} \begin{pmatrix} x_{1i} \\ x_{2i} \\ x_{3i} \\ x_{4i} \\ 1 \end{pmatrix} \qquad (2)$$

$$\text{但し、} i = 1 \sim n$$

[Equation 2]

$$E_j = \sum_{i=1}^{n} (W_{ij}^2((y'_{1i} - y_{1i})^2 + (y'_{2i} - y_{2i})^2 + (y'_{3i} - y_{3i})^2)) \qquad (3)$$

$$= \sum_{i=1}^{n} (W_{ij}^2(y'_{1i} - y_{1i})^2) + \sum_{i=1}^{n} (W_{ij}^2(y'_{2i} - y_{2i})^2) + \sum_{i=1}^{n} (W_{ij}^2(y'_{3i} - y_{3i})^2) \qquad (4)$$

$$E'_j = \sum_{i=1}^{n} (W_{ij}^2((k_1(y'_{1i} - y_{1i}))^2 + (k_2(y'_{2i} - y_{2i}))^2 + (k_3(y'_{3i} - y_{3i}))^2)) \qquad (5)$$

[Equation 3]

$$\begin{pmatrix} y_{1j} \\ y_{2j} \\ y_{3j} \end{pmatrix} = \begin{pmatrix} m_{11} & m_{12} & m_{13} & m_{14} \\ m_{21} & m_{22} & m_{23} & m_{24} \\ m_{31} & m_{32} & m_{33} & m_{34} \end{pmatrix} \begin{pmatrix} x_{1j} \\ x_{2j} \\ x_{3j} \\ 1 \end{pmatrix} \quad (6)$$

$$\begin{pmatrix} y_{1j} \\ y_{2j} \\ y_{3j} \end{pmatrix} = \begin{pmatrix} m_{11} & m_{12} & m_{13} & m_{14} & m_{15} \\ m_{21} & m_{22} & m_{23} & m_{24} & m_{25} \\ m_{31} & m_{32} & m_{33} & m_{34} & m_{35} \end{pmatrix} \begin{pmatrix} x_{1j} \\ x_{2j} \\ x_{3j} \\ x_{4j} \\ 1 \end{pmatrix} \quad (7)$$

[0017] (1) formula and (2) formulas First, the live data (x1i, x2i, x3i) of the input signal of an n-tuple, or (x1i, x2i, x3i, x4i) i= 1 - n, connecting with a matrix is shown so that it may become the relation of the alignment containing a constant term about the forecast (y1i', y2i', and y3i -- '), i= 1 - n, and it has become each component of a matrix of m11, m12, and ...

[0018] The following (3) formulas are the square sum Ej of the Euclidean distance of the output forecast calculated using the matrix shown in (1) formula or (2) formulas from the live data of two or more input signals, and two or more output live data corresponding to the live data of the input signal by which weighting was carried out. It is shown. here -- (-- y -- one -- i -- ' -- y -- two -- i -- ' -- y -- three -- i -- ' --) -- i -- = -- one - n -- (1) -- the live data (x1i, x2i, x3i) of the input signal of an n-tuple shown by the formula or (2) formulas -- or (x1i, x2i, x3i, x4i) It is the output forecast calculated using the matrix from i=1-n. (y1i, y2i, y3i), and i= 1 - n It is live data of the output signal of the n-tuple corresponding to i= 1 - n. (x1i, x2i, x3i) Or (x1i, x2i, x3i, x4i) Wij, i= 1 - n It is the coefficient of weighting to the output forecast calculated using the matrix shown in (1) formula or (2) formulas from the live data of these input signals, and the Euclidean distance between the live data of an output signal.

[0019] (6) How a formula calculates a forecast from forecasts-ed with an input signal arbitrary at three dimensions in case an output signal is three dimensions is shown, and m11, m12, and ... are each component of the same matrix as (1) formula. When a forecast-ed is an input signal (x1j, x2j, x3j), it can ask for the output signal (y1j, y2j, y3j) which is a forecast easily by substituting for (6) formulas. When a forecast-ed is an output signal (y1j, y2j, y3j), the input signal (x1j, x2j, x3j) which is a forecast can be searched for by solving (6) formulas conversely similarly.

[0020] (7) How, as for a formula, an input signal calculates a forecast in case an output signal is three dimensions in four dimensions is shown, and m11, m12, and ... are each component of the same matrix as (2) formulas. When a forecast-ed is an input signal (x1j, x2j, x3j, x4j), it can ask for the output signal (y1j, y2j, y3j) which is a forecast easily by substituting for (7) formulas. the input signal which is an input signal which it specifies as the part, for example, (x4j), the forecast-ed, of an input signal, and (7) formulas are solved conversely, and is the remaining forecast since (7) formulas cannot be conversely solved when a forecast-ed is an output signal (y1j, y2j, y3j) -- for example, (x1j, x2j, x3j), it can ask

[0021] Thus, even when the dimension of an input signal is four dimensions, it can treat on a par with the case of three dimensions. Of course, irrespective of a number of dimension, it can predict and the application range is latus. Moreover, since input / output relation is tied up with comparatively simple linear relation, extrapolation capacity is strong, even if the live-data pair of I/O does not cover the whole region of an I/O color space, in the whole region of an I/O color space, it is usable, and it can be used also for the property prediction besides the color gamut of an I/O color space.

[0022] By using the well-known method called least-squares method, when the coefficient Wij of weighting, i= 1 - n have become settled, it is Ej. It can ask for each components m11 and m12 of a matrix, and ... on conditions which are made into the minimum. However, since it is not uniquely decided when dependent on the input value the coefficient Wij of the aforementioned weighting, i= 1 - whose n are the components or forecasts of a matrix, it is Ej of (3) formulas. Under the conditions of considering as the minimum, the coefficient Wij of weighting, the components m11 and m12 of i= 1 - n, and a matrix, and the optimum value of ... and a forecast are determined using the technique of successive approximations.

[0023] In addition, Ej Since it can decompose into the sum of a positive component about each signal component of output signal space as shown in (4) formulas which transformed (3) formulas, considering as the minimum is equivalent to it being independent and making into the minimum the amount decomposed into each signal component. the

difference of two or more output live data corresponding to the output forecast and it which asked for the following (5) formulas using the matrix from the live data of two or more input signals -- every signal component -- constant twice -- square sum Ej' of the distance by which weighting was carried out to the value carried out is shown The method of this invention can completely be similarly applied, when making Ej' as shown in (5) formulas into the minimum.

[0024] moreover, the input space where the coefficient Wij of weighting standardized the difference for every signal component with the live data of the input signal of a forecast-ed or a forecast, and an input signal -- difference -- with the monotonically decreasing function Fij of the Euclidean distance in the standardization input signal space for which it asks from a component the monotonically decreasing function Gij of the Euclidean distance in the standardization output signal space for which it standardizes and asks after changing into the component of the output space which considered sensitivity using the component of this matrix by the difference for every signal component with the live data of the input signal of a forecast-ed or a forecast, and an input signal -- since -- it constitutes Thus, by constituting the coefficient Wij of weighting by the monotonically decreasing function of Euclidean distance, about live data with the large difference of distance, weight can be made small, influence can be lessened, weight can be enlarged about live data with the small difference of distance, and it can treat as important data. Moreover, the coefficient of color processing of a color picture I/O device can be decided without securing the continuity of a forecast theoretically and caring about the discontinuity between parts, since these function configurations are monotonically decreasing functions.

[0025] An output signal takes for an example the case where an input signal is three dimensions in-dimensional [3] or four dimensions about this, and explains using (12) formulas from (8) formulas shown below. (8) A formula and (10) formulas correspond, when an input signal is three dimensions, (9) formulas and (11) formulas correspond, when an input signal is [an output signal] three dimensions in four dimensions, and in both cases, (12) formulas correspond.

[0026]

[Equation 4]

$$W_{1ij} = F_{ij}(((x_{1i} - x_{1j})/x_{10})^2 + ((x_{2i} - x_{2j})/x_{20})^2 + ((x_{3i} - x_{3j})/x_{30})^2) \quad (8)$$

$$W_{1ij} = F_{ij}(((x_{1i} - x_{1j})/x_{10})^2 + ((x_{2i} - x_{2j})/x_{20})^2 + ((x_{3i} - x_{3j})/x_{30})^2 + ((x_{4i} - x_{4j})/x_{40})^2) \quad (9)$$

$$\begin{aligned} W_{2ij} = {} & G_{ij}(((m_{11}(x_{1i} - x_{1j}))^2 + (m_{12}(x_{2i} - x_{2j}))^2 \\ & +(m_{13}(x_{3i} - x_{3j}))^2)/(y_{10})^2 \\ & +((m_{21}(x_{1i} - x_{1j}))^2 + (m_{22}(x_{2i} - x_{2j}))^2 \\ & +(m_{23}(x_{3i} - x_{3j}))^2)/(y_{20})^2 \\ & +((m_{31}(x_{1i} - x_{1j}))^2 + (m_{32}(x_{2i} - x_{2j}))^2 \\ & +(m_{33}(x_{3i} - x_{3j}))^2)/(y_{30})^2) \end{aligned} \quad (10)$$

$$\begin{aligned} W_{2ij} = {} & G_{ij}(((m_{11}(x_{1i} - x_{1j}))^2 + (m_{12}(x_{2i} - x_{2j}))^2 \\ & +(m_{13}(x_{3i} - x_{3j}))^2 + (m_{14}(x_{4i} - x_{4j}))^2)/(y_{10})^2 \\ & +((m_{21}(x_{1i} - x_{1j}))^2 + (m_{22}(x_{2i} - x_{2j}))^2 \\ & +(m_{23}(x_{3i} - x_{3j}))^2 + (m_{24}(x_{4i} - x_{4j}))^2)/(y_{20})^2 \\ & +((m_{31}(x_{1i} - x_{1j}))^2 + (m_{32}(x_{2i} - x_{2j}))^2 \\ & +(m_{33}(x_{3i} - x_{3j}))^2 + (m_{34}(x_{4i} - x_{4j}))^2)/(y_{30})^2) \end{aligned} \quad (11)$$

$$W_{12ij} = H(W_{1ij}, W_{2ij}) \quad (12)$$

[0027] first, the input space which standardized the difference for every signal component of the input signal of the forecast-ed or forecast (8) formulas and whose (9) formulas are the elements of the coefficient of weighting, and live data -- difference -- the monotonically decreasing function of the Euclidean distance in the standardization input signal space for which it asks from a component is shown Here (x1j, x2j, x3j) (x1j, x2j, x3j, x4j) Or the input signal of a forecast-ed or a forecast, (x1i, x2i, x3i) Or (x1i, x2i, x3i, x4i) the live data of an input signal or (x10, x20, x30) (x10, x20, x30, x40) the constant of standardization of input signal space, and Fij are monotonically decreasing functions. By (8) formulas, for example, the difference for every signal component with the live data (x1i, x2i, x3i) of the input signal (x1j, x2j, x3j) of a forecast-ed or a forecast, and an input signal (x1i-x1j), It asks for (x2i-x2j) and (x3i-x3j), standardizes by the constant (x10, x20, x30) of standardization of this, and carries out to (x1i-x1j) / x10, (x2i-x2j) / x20, and (x3i-x3j) / x30. These square sums are made into the parameter of a monotonically decreasing function Fij.
[0028] Next, (10) formulas and (11) formulas show the monotonically decreasing function of the Euclidean distance in the standardization output signal space for which it standardizes and asks, after changing the difference for every signal component with the live data of the input signal of a forecast-ed or a forecast, and an input signal into the component of the output space which considered sensitivity using the component of this matrix. The input signal of here, a forecast-ed, or a forecast, (x1i, x2i, x3i) Or (x1i, x2i, x3i, x4i) the component of the matrix of the above-mentioned [the live data of an input signal m11 and m12, and ...], the constant of standardization of (y10, y20, y30) of output signal space, and Gij are monotonically decreasing functions. After hanging the component of the difference for every signal component with the live data of the input signal of a forecast-ed or a forecast, and an input signal and matrix by changing into the

component of the output space which considered sensitivity here and carrying out a square for every signal component, compared with the method of meaning taking the sum, taking the sum, without carrying out a square, and changing into the Euclidean distance of the usual output space, the difference is large. When taking the sum, without carrying out a square, even if an absolute value is large, depending on the sign of each item, the sum may become small. (10) The absolute value of each term can be considered as sensitivity by carrying out a square like a formula and (11) formulas.

[0029] For example, (10) formulas ask for the difference (x1i-x1j) for every signal component with the live data (x1i, x2i, x3i) of the input signal (x1j, x2j, x3j) of a forecast-ed or a forecast, and an input signal, (x2i-x2j), and (x3i-x3j). Although it is convertible for the component of output space by imposing a matrix on this, the sum is taken after hanging and carrying out the square of the component of a matrix as mentioned above here. that is () [m11] (x1i-x1j) 2+ (m12 (x2i-x2j)) 2 + 2, 2 (m21 (x1i-x1j))+(m22 (x2i-x2j)) 2+(m23 (x3i-x3j)) 2, and 2 (m31 (x1i-x1j))+(m32 (x2i-x2j)) 2 (m13 (x3i-x3j)) + (m33 (x3i-x3j)) 2 It asks. Using the constant (y10, y20, y30) of standardization, the division of these is carried out, they are standardized, are added by 2, 2 (x20), and 2 (x30), respectively (y10), and it is considering as the parameter of a monotonically decreasing function Gij.

[0030] Next, it is shown that (12) formulas compound two above-mentioned monotonically decreasing functions, and create the coefficient of weighting. Here, it is necessary to compound the method of compounding for example, so that the feature that two functions which are the element are monotonically decreasing functions of each Euclidean distance may not be broken down, and an operation like the sum or a product can be used for it.

[0031] Thus, W12ij calculated by (12) formulas is the coefficient Wij of weighting of (3) formulas. Ej shown in (3) formulas by the least-squares method using the coefficient Wij of this weighting It asks for the components m11 and m12 of the matrix made into the minimum, and ... And a forecast is calculated using the matrix which consists of components m11 and m12 of the matrix searched for, and ... Furthermore, if needed, the coefficient of weighting is again calculated using this calculated forecast, and it is Ej. It asks for the components m11 and m12 of the matrix made into the minimum, and ..., and a forecast is re-calculated using this. By repeating such processing, it can converge and a forecast can obtain a desired forecast.

[0032] Drawing 1 is a flow chart which shows an example of operation in the gestalt of operation of the 1st of the color transfer-characteristics prediction method of this invention. The live data (x1i, x2i, x3i) of the input signal of the n-tuple which first was stated by (1) - (3) formula [two or more sets of live-data pairs of an I/O device which want to actually predict a property at the I/O live-data pair preparation process of S11, i.e., the above-mentioned,], and i= 1 - n, The live data (y1i, y2i, y3i) of the output signal of the n-tuple corresponding to it, i= 1 - n are prepared. As the example, in the case of a color scanner, the various color patches which have measured the color beforehand are made to read, the RGB value of an output is measured, and it is the chromaticity coordinate of an input, for example, L* a* b*. It is equivalent to preparing a live-data pair with the RGB value of an output. Moreover, in a display, it is the RGB value of an input and the color coordinate of an output, for example, L* a* b*, by displaying a color patch in the various combination of the RGB value of an input, and measuring the color. It is equivalent to preparing a live-data pair. In the case of a further 4 color color printer, it is YMCK% of an input and the chromaticity coordinate of an output, for example, L* a* b*, by outputting a color patch in input [YMCK% of] various combination, and measuring the color. It is equivalent to preparing a live-data pair.

[0033] Next, when the forecast-ed stated by the above-mentioned (6) formulas and (7) formulas by the forecast-ed preparation process of S12, i.e., a forecast-ed, is an input signal, (x1j, x2j, x3j) Or when a forecast-ed is an output signal about (x1j, x2j, x3j, x4j) again, only a required number prepares (y1j, y2j, y3j) or (y1j, y2j, y3j), and (x4j).

[0034] Next, the initial value of the coefficient Wij of weighting of an n-tuple shown by (3) formulas is computed at the initial value calculation process of the coefficient of weighting of S13. It is important for initial value to make it the value possible near the value finally determined with the successive approximation method in order to bring convergence forward. for example, the input space which standardized the difference for every signal component of the live data of the forecast-ed input signal shown in (8) formulas and (9) formulas, and an input signal when a forecast-ed was an input signal -- difference -- weight W1ij of the monotonically decreasing function Fij of the Euclidean distance in the standardization input signal space for which it asks from a component It uses. The monotonically decreasing function Gij shown in (10) formulas and (11) formulas since the component of a matrix was not determined in this stage does not use, but is weight W1ij. It considers as initial value.

[0035] Output space is substituted when a forecast-ed is an output signal. the output space which standardized the difference for every signal component with the live data of the forecast-ed output signal shown in (13) formulas shown below when an input was three dimensions -- difference -- weight W2ij' of the monotonically decreasing function Gij of the Euclidean distance in the standardization input signal space for which it asks from a component is used moreover -- an input -- four -- a dimension -- it is -- a case -- (-- 13 --) -- a formula -- having been shown -- weight -- W -- two -- ij -- ' -- (-- 14 --) -- a formula -- having been shown -- an input -- space -- one -- a ** -- difference -- a component -- having

standardized -- an input signal -- space -- it can set -- distance -- a monotonically decreasing function -- Gij -- depending -- weight -- W -- two -- ij -- ' -- (--
[0036]
[Equation 5]

$$W'_{2ij} = G_{ij}(((y_{1i} - y_{1j})/y_{10})^2 + ((y_{2i} - y_{2j})/y_{20})^2 + ((y_{3i} - y_{3j})/y_{30})^2) \quad (13)$$

$$W'_{1ij} = F_{ij}(((x_{4i} - x_{4j})/x_{40})^2) \quad (14)$$

$$W'_{12ij} = H(W'_{1ij}, W'_{2ij}) \quad (15)$$

[0037] Next, the square sum Ej of the Euclidean distance by which weighting of two or more output live data corresponding to it was carried out to the output forecast calculated at the component calculation process of the matrix of S14 using the matrix from the live data of two or more input signals shown by (3) formulas A least-squares method is used for the basis of the conditions of making it the minimum, and each components m11 and m12 of a matrix and ... are computed for a while. The coefficient Wij of weighting used here is the weight decided at the initial value calculation process of the coefficient of weighting of S13.
[0038] Next, a forecast is computed for a while from a forecast-ed at the forecast calculation process of S15 using (6) formulas or (7) formulas. A forecast-ed An input signal (x1j, x2j, x3j) In (x1j, x2j, x3j, x4j), or (y1j, y2j, y3j) a forecast-ed -- an output signal (y1j, y2j, y3j) -- with or (y1j, y2j, y3j), when it is (x4j), it asks for (x1j, x2j, x3j) using each components m11 and m12 of the matrix searched for at the component calculation process of the matrix of S14, and ...
[0039] At the re-calculation process of the coefficient of weighting of S16, next, (8) formulas or (9) formulas, the input space which standardized the difference for every signal component with the live data of the input signal of a forecast-ed or a forecast, and an input signal -- difference -- weight W1ij of the monotonically decreasing function Fij of the Euclidean distance in the standardization input signal space for which it asks from a component (10) A formula or (11) formulas, weight W2ij of the monotonically decreasing function Gij of the Euclidean distance in the standardization output signal space for which it standardizes and asks after changing into the component of the output space which considered sensitivity using the component of the matrix by the difference for every signal component with the live data of the input signal of a forecast-ed or a forecast, and an input signal (12) -- the composite function H of a formula -- compounding -- the base of an n-tuple -- weight W12ij is again calculated to a data pair
[0040] Next, the square sum Ej of the Euclidean distance by which weighting of two or more output live data corresponding to it was carried out to the output forecast calculated at the component calculation process of the matrix of S17 using the matrix from the live data of two or more input signals shown by (3) formulas A least-squares method is used for the basis of the conditions of making it the minimum, and each components m11 and m12 of a matrix and ... are computed again.
[0041] Next, a forecast is again computed from a forecast-ed at the forecast re-calculation process of S18 using (6) formulas or (7) formulas. a forecast-ed -- an input signal (x1j, x2j, x3j) -- or (x1j, x2j, x3j, x4j) -- it is -- a case (y1j, y2j, y3j) a forecast-ed -- an output signal (y1j, y2j, y3j) -- with or (y1j, y2j, y3j), when it is (x4j), it asks for (x1j, x2j, x3j) using each components m11 and m12 of the matrix searched for at the component re-calculation process of the matrix of S17, and ...
[0042] Next, it judges whether at the convergence-test process of the forecast of S19, the forecast calculated at the forecast re-calculation process of S18 was compared with the forecast calculated at the forecast calculation process of S15, or the forecast re-calculation process of S18 of 1 time ago, and it was completed by the forecast. As the method of a judgment, it asks for the difference between this forecast and a previous forecast for every component, and when the absolute value is smaller than the threshold for every component set up beforehand, it can judge with converging, for example. Or when the Euclidean distance between this forecast and a previous forecast is smaller than the threshold set up beforehand, it can also judge with converging. Here, if it judges with not progressing and converging on the prediction end judging process of S22 by making into a final forecast the forecast calculated at the forecast re-calculation process of S18 this time if it judges with converging, it will progress to the re-calculation judging process of the forecast of S20.
[0043] The re-calculation judging process of the forecast of S20 is a process which judges whether the convergence

direction of a forecast and the number of times of convergence calculation are investigated, and convergence calculation is made to perform further. When not emitting and converging according to this process around extremal value with a forecast, it is made not to lapse into the calculation loop of an infinite time. For example, when this process is the 1st time, it judges [re-calculating a forecast unconditionally and], and the relation between a forecast and the forecast of 1 time ago and the relation between the forecast of 1 time ago and the forecast of 2 times ago are investigated for every component, and 2nd henceforth judges [re-calculating a forecast and] them, when having shifted in the same direction. What is necessary is not re-calculating, since it does not emit and converge when the number of times was counted when having shifted in the different direction, it judges [re-calculating and] when it is below the threshold that counted value set up beforehand, and a threshold is exceeded, and just to judge. Here, if it judges [re-calculating a forecast and], it will progress to the re-calculation process of the coefficient of weighting of S16, and convergence calculation will be repeated, and if it judges [not re-calculating and], it will progress to the forecast terminal-decision process of S21.

[0044] The forecast terminal-decision process of S21 is a process which determines the value most appropriate for it as a final forecast, when not emitting and converging around extremal value with a forecast. The value most appropriate for it is determined as a final forecast -- memorize the forecast which re-calculated, for example, take the average of the total forecast after beginning emission, or with a forecast and a forecast [1st] difference chooses the smallest forecast.

[0045] The following prediction end judging process of S22 is a process a forecast judges whether calculation was completed or not about all forecasts-ed to be, in not ending, it returns to the initial value calculation process of the coefficient of weighting of S13, prediction is repeated about the following forecast-ed, and, in an end, all color transfer-characteristics prediction processings of a color picture I/O device are ended.

[0046] Next, the gestalt of operation of the 2nd of the color transfer-characteristics prediction method of this invention is explained. With the gestalt of this 2nd operation, as a coefficient Wij of weighting of (3) formulas the input space which standardized the difference for every signal component with the live data of the input signal of the forecast-ed or forecast used with the gestalt of the 1st operation of a ****, and an input signal -- difference -- with the monotonically decreasing function Fij of the Euclidean distance in the standardization input signal space for which it asked from the component Besides the monotonically decreasing function Gij of the Euclidean distance in the standardization output signal space which was standardized after changing into the component of the output space which considered sensitivity using the component of this matrix by the difference for every signal component with the live data of the input signal of a forecast-ed or a forecast, and an input signal and for which it asked Data precision function Ji The example to be used is shown. This data precision function Ji They are the two above-mentioned kinds of weight W1ij(s) to the live data of an input signal. W2ij It is the function calculated from the interrelation of the output forecast used and predicted and the live data of an output signal, and the probability containing a noise of each live-data pair is expressed.

[0047] the input space which standardized the difference for every signal component with the live data of the input signal of a forecast-ed or a forecast here -- difference -- with the monotonically decreasing function Fij of the Euclidean distance in the standardization input signal space for which it asked from the component The monotonically decreasing function Gij of the Euclidean distance in the standardization output signal space which was standardized after changing into the component of the output space which considered sensitivity using the component of this matrix by the difference for every signal component with the live data of the input signal of a forecast-ed or a forecast and an input signal and for which it asked data precision function Ji calculated from the interrelation of the output forecast predicted to the live data of an input signal using two kinds of such weight, and the live data of an output signal since it is the same as what was shown with the gestalt of the 1st operation of a **** The case where an output signal is three dimensions is taken for an example. ******** -- It explains using (23) formulas from (16) formulas shown below.

[0048]

[Equation 6]

$$\Delta y_{i1} = y'_{i1} - y_{i1} \tag{16}$$

$$\Delta y_{i2} = y'_{i2} - y_{i2} \tag{17}$$

$$\Delta y_{i3} = y'_{i3} - y_{i3} \tag{18}$$

$$\Delta y_{is1} = \left(\sum_{k=1}^{n}(V_k(y'_{1k} - y_{1k}))\right) / \left(\sum_{k=1}^{n}(V_k)\right) \tag{19}$$

但し、kはi以外

$$\Delta y_{is2} = \left(\sum_{k=1}^{n}(V_k(y'_{2k} - y_{2k}))\right) / \left(\sum_{k=1}^{n}(V_k)\right) \tag{20}$$

但し、kはi以外

$$\Delta y_{is3} = \left(\sum_{k=1}^{n}(V_k(y'_{3k} - y_{3k}))\right) / \left(\sum_{k=1}^{n}(V_k)\right) \tag{21}$$

但し、kはi以外

$$W_{3i} = J_i(I_{i1}(\Delta y_{i1}, \Delta y_{is1}), I_{i2}(\Delta y_{i2}, \Delta y_{is2}), I_{i3}(\Delta y_{i3}, \Delta y_{is3})) \tag{22}$$

$$W_{123ij} = H(W_{1ij}, W_{2ij}, W_{3i}) \tag{23}$$

[0049] (16) the difference of an output forecast [in / the i-th live-data pair / in a formula to (18) formulas] (yi1', and yi2' and yi3 -- '), and output live data (yi1, yi2, yi3) -- the difference of the output forecast in the live-data pair the element is shown and excluding / (19) formulas to (21) formulas / the i-th live-data pair, and ****** data -- an element -- weighting factor Vk What carried out the weighting the input space where weight here standardized the difference for every signal component of the input signal of the i-th live data, and the input signal of live data other than the i-th -- difference -- the monotonically decreasing function of the Euclidean distance in the standardization input signal space for which it asks from a component -- then, it is good

[0050] the following (22) formulas -- the difference to (16) to (21) formula -- an element -- difference -- the data precision function for which is made to correspond for every element and it asks is shown data precision function Ji shown here the difference of the output forecast and output live data about the i-th live-data pair -- the difference of a weighting average with the output forecast and output live data about the live-data pair of a live-data pair except the live-data pair of size **yi1 of a direction and its difference, **yi2, and 3 or i-th **yi -- size **yis1 of a direction and its difference -- **yis2 and **yis3 It is the feature to use the functions Ii1, Ii2, and Ii3 which show the probability of a live-data pair which took such a small value that the size of a difference will become large about such a big value that the size of a difference becomes large if a shell and both are the same directions if it is a different direction.

[0051] The following (23) formulas are weight W1ij which used two monotonically decreasing functions Fij and Gij, and W2ij. Data precision function Ji Used weight W3i is compounded by the composite function H, and it is coefficient W123ij of weighting. Creating is shown. Here, the synthetic method that the feature that two monotonically decreasing functions which are the element are monotonically decreasing functions of each Euclidean distance is not broken down, and the synthetic method that the feature that a data precision function shows the probability of a live-data pair is not broken down need to be used for the method of compounding, for example, a synthetic method like the sum or a product can be used for it.

[0052] The flow chart which shows an example of operation [in / the gestalt of operation of the 2nd of the color

transfer-characteristics prediction method of this invention / in drawing 2], and drawing 3 are flow charts which show the detail of a data precision function preparation process. The example which enabled it to use a data precision function alternatively is shown here, and when not using a data precision function is chosen, it is the same as the gestalt of the 1st operation of a ****. Since the I/O live-data pair preparation process of S11 is completely the same as that of the case where weight by the data precision function is not used, explanation is omitted. Next, it judges whether at the data precision function weight use judging process of S23, the coefficient of weighting using the data precision function is used. In not using, it progresses to S12, and processing explained with the gestalt of the 1st operation of a **** is performed. In using the coefficient of weighting using the data precision function, it progresses to the data precision function weight preparation process of S24.

[0053] The data precision function weight preparation process of S24 is shown in drawing 3 . Hereafter, it explains using drawing 3 . At the forecast-ed setting process of S31, all the input live data prepared at the I/O live-data pair preparation process of S11 of drawing 2 are set up as a forecast-ed, and the preparations which predict the output value to input live data less than [S32] are made.

[0054] Next, the initial value of the coefficient Wij of weighting of the n-tuple stated by (3) formulas is computed at the initial value determination process of the coefficient of weighting of S32. the input space which standardized the difference for every signal component with the live data of the forecast-ed input signal which showed initial value in (8) formulas, and an input signal -- difference -- weight W1ij of the monotonically decreasing function Fij of the Euclidean distance in the standardization input signal space for which it asks from a component What is necessary is just to use.

[0055] Next, the square sum Ej of the Euclidean distance by which weighting of two or more output live data corresponding to it was carried out to the output forecast calculated at the component calculation process of the matrix of S33 using the matrix from the live data of two or more input signals shown by (3) formulas A least-squares method is used for the basis of the conditions of making it the minimum, and each components m11 and m12 of a matrix and ... are computed for a while. The coefficient Wij of weighting here is the coefficient Wij of weighting decided at the initial value calculation process of the coefficient of weighting of S32.

[0056] Next, a forecast is computed for a while from a forecast-ed at the forecast calculation process of S34 using (6) formulas. Since a forecast-ed is an input signal (x1j, x2j, x3j), it asks for (y1j, y2j, y3j) using each components m11 and m12 of the matrix searched for at the component calculation process of the matrix of S33, and ...

[0057] At next, the re-calculation process of the coefficient of weighting of S35 (8) -- the input space which standardized the difference for every signal component with the live data of the input signal of the forecast-ed shown in a formula, or a forecast, and an input signal -- difference -- weight W1ij of the monotonically decreasing function Fij of the Euclidean distance in the standardization input signal space for which it asks from a component (10) It standardizes, after changing the difference for every signal component with the live data of the input signal of the forecast-ed shown in a formula, or a forecast, and an input signal into the component of the output space which considered sensitivity using the component of this matrix. weight W2ij of the monotonically decreasing function Gij of the Euclidean distance in the standardization output signal space for which it asks weight W12ij compounded by the composite function H shown in (12) formulas -- the base of an n-tuple -- it calculates again to a data pair

[0058] Next, the square sum Ej of the Euclidean distance by which weighting of two or more output live data corresponding to it was carried out to the output forecast calculated at the component re-calculation process of the matrix of S36 using the matrix from the live data of two or more input signals shown by (3) formulas A least-squares method is used for the basis of the conditions of making it the minimum, and each components m11 and m12 of a matrix and ... are computed again.

[0059] Next, a forecast is again computed from a forecast-ed at the forecast re-calculation process of S37 using (6) formulas. Since a forecast-ed is an input signal (x1j, x2j, x3j), it asks for (y1j, y2j, y3j) using each components m11 and m12 of the matrix searched for at the component calculation process of the matrix of S36, and ...

[0060] Next, it judges whether at the convergence-test process of the forecast of S38, the forecast calculated at the forecast re-degree calculation process of S37 was compared with the forecast calculated at the forecast calculation process of S34, or the forecast re-calculation process of S37 of 1 time ago, and it was completed by the forecast. As the method of a judgment, it asks for the difference between this forecast and the last forecast for every component, and when the absolute value is smaller than the threshold for every component set up beforehand, it can judge with converging, for example. Or when the Euclidean distance between this forecast and the last forecast is smaller than the threshold set up beforehand, it can also judge with converging. Here, if it judges with not progressing and converging on the prediction end judging process of S41 by making into a final forecast the forecast calculated at the forecast re-calculation process of S37 if it judges with converging, it will progress to the re-calculation judging process of the forecast of S39.

[0061] The re-calculation judging process of the forecast of S39 is a process which judges whether the convergence

direction of a forecast and the number of times of convergence calculation are investigated, and convergence calculation is made to perform further. When not emitting and converging by this processing around extremal value with a forecast, it is made not to lapse into the calculation loop of an infinite time. For example, when this process is the 1st time, it judges [re-calculating a forecast unconditionally and], and the relation between this forecast and the last forecast and the relation between the last forecast and a forecast before last are investigated for every component, and 2nd henceforth judges [re-calculating a forecast and] them, when having shifted in the same direction. What is necessary is not re-calculating, since it does not emit and converge when the number of times was counted when having shifted in the different direction, it judges [re-calculating and] when it is below the threshold that counted value set up beforehand, and a threshold is exceeded, and just to judge. Here, if it judges [re-calculating a forecast and], it will progress to the re-calculation process of the weighting factor of S35, and convergence calculation will be repeated, and if it judges [not re-calculating and], it will progress to the forecast terminal-decision process of S40.

[0062] The forecast terminal-decision process of S40 is a process which determines the value most appropriate for it as a final forecast, when not emitting and converging around extremal value with a forecast. The average of the total forecast after memorizing the forecast which re-calculated, for example, beginning is taken, or difference with this forecast determines the value most appropriate for it by choosing the smallest forecast etc. as a final forecast.

[0063] It is the process which judges whether calculation of a forecast ended the following prediction end judging process of S41 about all forecasts-ed, and in not ending, it returns to the initial value calculation process of the weighting factor of S32, it repeats prediction about the following forecast-ed, and, in an end, it progresses to the data precision function weight calculation process of S42.

[0064] The following data precision function weight calculation process of S42 is the data precision function Ji shown in (22) formulas from (16) formulas. Data precision function weight W3i is computed by following. the difference of an output forecast and output live data concerning [a data precision function] an object live-data pair -- the size of a direction and its difference -- the difference of a weighting average with the output forecast and output live data about the live-data pair of a live-data pair except an object live-data pair -- from the size of a direction and its difference It is the function which took such a small value that the size of a difference will become large about such a big value that the size of a difference becomes large if both are the same directions if it is a different direction and which shows the probability of a live-data pair.

[0065] It is the process which judges whether the weight calculation by the data precision function ended the following data precision function weight calculation end judging process of S43 about all I/O live-data pairs, and in not ending, it returns to the data precision function weight calculation process of S42, and it repeats the weight calculation by the data precision function about the following I/O live-data pair. In an end, it progresses to the forecast-ed preparation process of S12 of drawing 2 .

[0066] Since the prediction processes from S12 to S22 of drawing 2 are almost the same when using data precision function weight, and when not using, only a different portion adds explanation. At the initial value calculation process of the coefficient of weighting of S13, the initial value of the weighting factor Wij of an n-tuple shown by (3) formulas is computed. the input space where the initial value in this case standardized the difference for every signal component with the live data of the forecast-ed input signal shown in (8) formulas or (9) formulas, and an input signal when a forecast-ed was an input signal -- difference -- weight W1ij of the monotonically decreasing function Fij of the Euclidean distance in the standardization input signal space for which it asks from a component What compounded data precision function weight W3i by (24) formulas shown below is used. the output space which standardized the difference for every signal component with the live data of the forecast-ed output signal shown in (13) formulas, and an output signal when a forecast-ed was an output signal and an input was three dimensions -- difference -- what compounded weight W2ij' of the monotonically decreasing function Gij of the Euclidean distance in the standardization input signal space for which it asks from a component, and data precision function weight W3i by (25) formulas shown below is used an input -- four -- a dimension -- it is -- a case -- (-- 13 --) -- a formula -- weight -- W -- two -- ij -- ' -- (-- 14 --) -- a formula -- having been shown -- an input -- space -- one -- a ** -- difference -- a component -- having standardized -- an input signal -- space -- it can set -- distance -- a monotonically decreasing function -- Fij -- depending -- weight -- W -- one -- ij -- ' -- data -- precision -- a function -- weight

[0067]

[Equation 7]

$$W'_{13ij} = H(W_{1ij}, W_{3i}) \qquad (24)$$

$$W'_{23ij} = H(W'_{2ij}, W_{3i}) \qquad (25)$$

$$W'_{123ij} = H(W'_{1ij}, W'_{2ij}, W_{3i}) \qquad (26)$$

[0068] At the re-calculation process of the coefficient of weighting of S16 (8) -- the input space which standardized the difference for every signal component with the live data of the input signal of the forecast-ed shown in a formula or (9) formulas, or a forecast, and an input signal -- difference -- weight W1ij by the monotonically decreasing function Fij of the Euclidean distance in the standardization input signal space for which it asks from a component (10) It standardizes, after changing the difference for every signal component with the live data of the input signal of the forecast-ed shown in a formula or (11) formulas, or a forecast, and an input signal into the component of the output space which considered sensitivity using the component of this matrix. Weight W2ij by the monotonically decreasing function Gij of the Euclidean distance in the standardization output signal space for which it asks Data precision function Ji shown in (22) formulas Weight W3i to depend is compounded by the composite function H of (23) formulas, and it is weight W123ij to the live-data pair of an n-tuple. It calculates again.
[0069] When using data precision function weight, and when not using, it is completely the same, and except S13 and S16 of a more than, prediction in the case of using data precision function weight can be carried out by passing through the prediction processes from S12 to S22.
[0070] Next, the form of operation of the 3rd of the color transfer-characteristics prediction method of this invention is explained. the input space standardized by breaking the difference for every signal component with the live data of the input signal of a forecast-ed, and an input signal used with the form of the 1st operation as a coefficient Wij of weighting of (3) formulas by the constant for every signal component by the form of this 3rd operation -- difference -- the example only using the monotonically decreasing function Fij of the Euclidean distance in the standardization input signal space for which it asks from a component is shown
[0071] here -- -ed -- a forecast -- an input signal -- an input signal -- live data -- a signal component -- every -- a difference -- each -- a component -- every -- a constant -- dividing -- things -- having standardized -- an input -- space -- difference -- a component -- from -- asking -- standardization -- an input signal -- space -- it can set -- Euclidean distance -- a monotonically decreasing function -- Fij -- a **** -- the -- one -- operation -- a form -- having been shown -- (-- eight --) -- a formula -- or -- (Since a monotonically decreasing function Fij is dependent on the input signal which is a forecast when searching for the input signal which is a forecast corresponding to the arbitrary output signals which are forecasts-ed, the color transfer-characteristics prediction method becomes completely the same as the method shown in drawing 1 as a coefficient Wij of weighting of (3) formulas except using Wij shown in (8) formulas or (9) formulas instead of using W12ij of (12) formulas. Therefore, the case where it asks for the output signal which is a forecast corresponding to the arbitrary input signals which are forecasts-ed here is explained.
[0072] Drawing 4 is a flow chart which shows an example of operation in the case of asking for the output signal which is a forecast corresponding to the arbitrary input signals which are forecasts-ed in the form of operation of the 3rd of the color transfer-characteristics prediction method of this invention. Although it is the I/O live-data pair preparation process of S51, since this is completely the same as that of the I/O live-data pair preparation process of S11 shown in drawing 1 at first, explanation is omitted.
[0073] Next, at the forecast-ed preparation process of S52, since it is the case where a forecast-ed is an input signal, only a required number prepares the input signal (x1j, x2j, x3j) or input signal (x1j, x2j, x3j, x4j) of a forecast-ed stated by above-mentioned (6) formulas and (7) formulas.
[0074] Next, the coefficient Wij of weighting of the n-tuple stated by (3) formulas is computed at the calculation process of the weighting coefficient of S53. the input space which is the case where a forecast-ed is an input signal, and was standardized as a coefficient of weighting by dividing the difference for every signal component with the live data of the input signal of the forecast-ed shown in (8) formulas or (9) formulas, and an input signal by the constant for every signal component -- difference -- it can ask uniquely that what is necessary is to ask only for the monotonically decreasing function Fij of the Euclidean distance in the standardization input signal space for which it asks from a component
[0075] Next, the square sum Ej of the Euclidean distance to which weighting of the live data of two or more output signals corresponding to the output forecast and it for which it asked at the component calculation process of the matrix

of S54 using the matrix from the live data of two or more input signals shown by (3) formulas was carried out On the basis of the conditions of making it the minimum, each components m11 and m12 of a matrix and ... are computed using the well-known method of a least-squares method.

[0076] Next, a forecast is computed from a forecast-ed at the forecast calculation process of S55 using (6) formulas or (7) formulas. Since it is the case where a forecast-ed is an input signal (x1j, x2j, x3j) or an input signal (x1j, x2j, x3j, x4j), it asks for an output signal (y1j, y2j, y3j) using each components m11 and m12 of the matrix searched for at the component calculation process of the matrix of S54, and ...

[0077] The following prediction end judging process of S56 is a process a forecast judges whether calculation was completed or not about all forecasts-ed to be, in not ending, it returns to the calculation process of the weighting coefficient of S53, and it repeats prediction about the following forecast-ed. All color transfer-characteristics prediction of the color picture I/O device in the case of using only a monotonically decreasing function Fij in an end is ended.

[0078] Since the coefficient of weighting can be uniquely defined when using only a monotonically decreasing function Fij by the case where it asks for the output signal which is a forecast corresponding to the arbitrary input signals which are forecasts-ed so that it may understand by the above explanation, predicting without using the successive approximation method is possible.

[0079] Next, the form of operation of the 4th of the color transfer-characteristics prediction method of this invention is explained. With the form of this 4th operation, as a coefficient Wij of weighting of (3) formulas the input space standardized by dividing the difference for every signal component with the live data of the input signal of a forecast-ed, and an input signal used with the form of the 1st operation by the constant for every signal component -- difference -- with the monotonically decreasing function Fij of the Euclidean distance in the standardization input signal space for which it asks from a component Data precision function Ji used with the form of the 2nd operation The example to be used is shown.

[0080] the input space standardized here by dividing the difference for every signal component with the live data of the input signal of a forecast-ed, and an input signal by the constant for every signal component -- difference -- the monotonically decreasing function Fij of the Euclidean distance in the standardization input signal space for which it asks from a component It is the same as (8) formulas or (9) formulas which were shown with the form of the 1st operation of a ****, and is the data precision function Ji. It is the same as the (16) formula - (22) formula shown with the form of the 2nd operation of a ****.

[0081] It is W1ij shown in (8) formulas or (9) formulas instead of W12ij of (12) formulas being used for the color transfer-characteristics prediction method as a coefficient Wij of weighting of (3) formulas since the monotonically decreasing function Fij was dependent on the input signal which is a forecast when the input signal which is a forecast corresponding to the arbitrary output signals which are forecasts-ed was searched for. Except using, it becomes completely the same as the method shown in drawing 2 or drawing 3 . Therefore, the case where it asks for the output signal which is a forecast corresponding to the arbitrary input signals which are forecasts-ed here is explained.

[0082] The flow chart and drawing 6 which show an example of operation in case drawing 5 asks for the output signal which is a forecast corresponding to the arbitrary input signals which are forecasts-ed in the gestalt of operation of the 4th of the color transfer-characteristics prediction method of this invention are a flow chart which similarly shows the detail of a data precision function preparation process. Here, the example which enabled it to use a data precision function alternatively is shown, and when not using a data precision function is chosen, it becomes completely the same as the gestalt of the 3rd operation of a ****. Although it is the I/O live-data pair preparation process of S61 at first, since this is completely the same as that of the I/O live-data pair preparation process of S11 in drawing 1 , explanation is omitted.

[0083] Next, it judges whether at the data precision function weight use judging process of S62, the weighting coefficient using the data precision function is used. When not using, it progresses to S64, and processing explained with the gestalt of the 3rd operation of a **** is performed. In using the coefficient of weighting using the data precision function, it progresses to the data precision function weight preparation process of S63. Since the data precision function weight preparation process of S63 is shown in drawing 6 , it explains using drawing 6 below.

[0084] At the forecast-ed setting process of S71, all the I/O live data prepared at the I/O live-data pair preparation process of S61 of drawing 5 are set up as a forecast-ed, and the preparations for predicting the output value to I/O live data less than [S72] are made.

[0085] Next, at the determination process of the coefficient of weighting of S72, the coefficient Wij of weighting of the n-tuple stated by (3) formulas is computed. the input space which is the case where a forecast-ed is an input signal, and was standardized as a coefficient of weighting by dividing the difference for every signal component with the live data of the forecast-ed input signal shown in (8) formulas or (9) formulas, and an input signal by the constant for every signal component -- difference -- it can set uniquely that what is necessary is to ask only for the monotonically decreasing

function Fij of the Euclidean distance in the standardization input signal space for which it asks from a component
[0086] Next, the square sum Ej of the Euclidean distance by which weighting of the live data of two or more output signals corresponding to it was carried out to the output forecast at the component calculation process of the matrix of S73 using the matrix from the live data of two or more input signals shown by (3) formulas On the basis of the conditions of making it the minimum, the components m11 and m12 of a matrix and ... are computed using the well-known method of a least-squares method. The coefficient of weighting here is a coefficient of weighting decided at the calculation process of the coefficient of weighting of S72.
[0087] Next, at the forecast calculation process of S74, a forecast is computed from a forecast-ed using (6) formulas or (7) formulas. Since a forecast-ed is an input signal (x1j, x2j, x3j), it asks for an output signal (y1j, y2j, y3j) using each components m11 and m12 of the matrix searched for at the component calculation process of the matrix of S73, and ...
[0088] The following prediction end judging process of S75 is a process a forecast judges whether calculation was completed or not about all forecasts-ed to be. In not ending, it returns to the calculation process of the coefficient of weighting of S72, and it repeats prediction about the following forecast-ed. In an end, it progresses to the data precision function weight calculation process of S76.
[0089] The data precision function weight calculation process of S76 computes data precision function weight according to the data precision function shown in (19) formulas from (16) formulas. the difference of the output forecast concerning [a data precision function] an object live-data pair and the live data of an output signal -- the size of a direction and its difference -- the difference of a weighting average with the output forecast about the live-data pair of a live-data pair and the live data of an output signal except an object live-data pair -- from the size of a direction and its difference It is the function which was made to make such a big value that the size of a difference become large if both are the same directions a value smaller if it is a different direction, as the size of a difference will become large and which shows the probability of a live-data pair.
[0090] The following data precision function weight calculation end process of S77 is a process which judges whether the weight calculation by the data precision function was completed about all I/O live-data pairs. In not ending, it returns to the data precision function weight calculation process of S76, calculation of data precision function weight is repeated about the following I/O live-data pair, and, in an end, it progresses to the forecast-ed preparation process of S64 in drawing 5 .
[0091] Since it is almost the same and only S64 differs when data precision function weight is used for the prediction processes from S64 to S68 of drawing 5 , and when not using, only S64 adds explanation.
[0092] At the calculation process of the weighting factor of S64, the coefficient Wij of weighting of the n-tuple stated by (3) formulas is computed. in this case, the input space which standardized the difference for every signal component with the live data of the input signal which is the forecast-ed shown in (8) formulas or (9) formulas since a forecast-ed is an input signal, and an input signal -- difference -- it can set uniquely that what is necessary is just to use what compounded the weight of the monotonically decreasing function of Euclidean distance and data precision function weight in the standardization input signal space for which it asks from a component by (24) formulas
[0093] As mentioned above, except S64 of drawing 5 , when using data precision function weight and not using, it is completely the same, and prediction using data precision function weight can be performed by passing through the prediction processes from S61 to S68. Since the coefficient of weighting can be uniquely defined when using only a monotonically decreasing function Fij by the case where it asks for the output signal which is a forecast corresponding to the arbitrary input signals which are forecasts-ed, even if it is the case where data precision function weight is used, as it understands by the above explanation, predicting without using the successive approximation method is possible.
[0094] As mentioned above, although four gestalten of operation of this invention were explained, in addition although the combination of the color transfer-characteristics prediction method shown in the data precision function shown in drawing 6 and drawing 2 is also possible, since it is the combination which can be guessed easily, explanation is omitted.
[0095]
[Example] Drawing 7 is the block diagram showing the 1st example of the system which applies the color transfer-characteristics prediction method of this invention. As for a color scanner, and 102-104, 101 are [a 1-dimensional table and 105] the matrix masking sections among drawing. Here, how to be on calculation and to check the precision of the method of determining the coefficient of color processing using the color transfer-characteristics prediction method of this invention, and its processing is explained, using a color scanner 101 as a color picture input unit.
[0096] In the system shown in drawing 7 , a color scanner 101 reads the given color picture, and outputs the signal of a RGB color space. As for the signal of the RGB color space outputted from a color scanner 101, in the 1-dimensional tables 102-104, color adjustment is performed for every signal component. The purpose of the 1-dimensional tables 102-104 is data of the RGB color space usually proportional to a reflection factor at the following matrix masking

section 105 L* a* b* So that conversion precision may become good, when changing into the data of a color space The difference in the sensitivity of each sensor of changing into data R'G'B' of units, such as another unit which is not a reflection factor, for example, concentration, and lightness, and RGB of a color scanner 101 An amendment sake, a color scanner -- 101 -- a gray -- inputting -- having had -- the time -- R -- ' -- G -- ' -- B -- ' -- being the same -- a value -- becoming -- as -- conversion -- giving -- things -- it is . equal color space L* which is not dependent on equipment in the matrix masking section 105 after changing 1-dimensional table 102-R, G, and B each component of every by 104 -- it changes and outputs to 'a*'b*' Equal color space L* a* b* which measured the color picture made to read with a color scanner 101 with the colorimetry vessel etc. at this time Live data and the data of L*'a*'b*' color space of the output of the matrix masking section 105 are made in agreement. The color picture data which can reproduce faithfully the color picture given to the color scanner 101 by this will be inputted.
[0097] Drawing 8 is a flow chart which shows an example of the color processing coefficient determination in the 1st example of the system which applies the color transfer-characteristics prediction method of this invention, and check processing. Here, the prediction method which does not use a data precision function and which was explained with the gestalt of the 1st operation shall be used as a prediction process of color transfer characteristics.
[0098] First, a color is beforehand measured at the I/O live-data pair preparation process of S81, and it is equal color space L* a* b*. A color scanner 101 is made to read the various color patches which obtained the data which can be set, and the signal in the RGB color space outputted from a color scanner 101 is measured. Thereby, it is equal color space L*a* b* as live data of an input signal. The live-data pair of data and the live data in the RGB color space of the output of a color scanner 101 can be prepared. As for the color of various color patches, being uniformly distributed in the color space of an input is desirable, and the number usually ranks 100 to 1000th, although it is dependent on the precision of prediction to desire.
[0099] Since the noise by causes, such as heterogeneity within the field of a color scanner and a time unstable property, has ridden on the output signal at the time of reading of a color picture, it is good to devise so that these noises may be easy to be removed by the smoothing feature which the color property prediction method has. Moreover, also as for the influence of a time unstable property, it is good for a RGB value by making the array random at the time of reading of a color patch, making it the influence of the heterogeneity within a field ride on the data of a RGB color space at random, or dividing into the scan of many times and extracting the data of a RGB color space to make it ride at random. Furthermore, after also taking the heterogeneity of the color patch itself into consideration, not being made to make small the size of the aperture at the time of measurement of a color too much or measuring the data of a RGB color space, it is still better to devise in quest of the average of the field corresponding to the size of aperture etc.
[0100] Next, the configuration and parameter of the function of weighting at the time of color transfer-characteristics prediction are set up at the weighting function configuration / parameter setup process of S82. For example, it sets up as a (27) - (29) formula showing the function of weighting equivalent to (8), (10), and (12) formulas below. Here, for (Lj, aj, and bj), the live data of an input signal, and (L0, a0 and b0) are [the input signal of a forecast-ed or a forecast, and (Li, ai and bi)] the constant of standardization of input signal space, the constant of standardization of (R0, G0, and B0) of output signal space, and the constant p decides a function configuration to be.
[0101]
[Equation 8]

$$W_{1ij} = 1/((((L_i - L_j)/L_0)^2 + ((a_i - a_j)/a_0)^2 + ((b_i - b_j)/b_0)^2)^p + 1) \quad (27)$$

$$\begin{aligned} W_{2ij} = 1/((((m_{11}(L_i - L_j))^2 + (m_{12}(a_i - a_j))^2 \\ +(m_{13}(b_i - b_j))^2)/(R_0)^2 \\ +((m_{21}(L_i - L_j))^2 + (m_{22}(a_i - a_j))^2 \\ +(m_{23}(b_i - b_j))^2)/(G_0)^2 \\ +((m_{31}(L_i - L_j))^2 + (m_{32}(a_i - a_j))^2 \\ +(m_{33}(b_i - b_j))^2)/(B_0)^2)^p + 1) \end{aligned} \quad (28)$$

$$W_{12ij} = W_{1ij} + W_{2ij} \quad (29)$$

[0102] The parameter of weighting means (L0, a0, b0), (R0, G0 and B0), and three kinds of constants of p here, and the grade of a smoothing feature is adjusted. As it understands in the configuration of a formula, a smoothing feature is a parameter with which (L0, a0, b0), and (R0, G0 and B0) become weak, so that, as for p, a value becomes large by a smoothing feature becoming strong, so that a value becomes large. Before these parameters perform prediction, they need to be determined by the grade of the noise of an I/O live-data pair. What is necessary is to strengthen a smoothing feature generally, if a noise is large, and just to weaken a smoothing feature, if a noise is small. However, since there is only an I/O live-data pair and, as for the data which usually judge the grade of a noise, the true value does not understand it, a certain grade will set up experientially.
[0103] For example, the group of a certain parameter is assumed, the output to input live data is predicted, the difference of a forecast and output live data is seen, and there is the method of choosing the group of a certain suitable parameter. In this case, the difference of a forecast and output live data is that by which the error of the anticipation method itself and the error by the noise were compounded, and should just ask for the relation between this difference and the group of an optimal parameter by the simulation etc. beforehand.
[0104] As another example, it is L* a* b* as a forecast-ed. It is L* in the gradation data of a color space, a* =b* =0 [for example,]. A forecast-ed which changes little by little is prepared, the group of a certain parameter is assumed, and the data of a RGB color space are predicted. And L* The data of the receiving RGB color space of a prediction result are graph-ized, and it judges whether the group of the assumed parameter is sufficient from the configuration. For example, a group of a parameter which the result follows a live-data pair too much, and gives stronger smoothing since the smoothing feature is too weak when there is much unnatural extremal value is assumed again, and it judges similarly. The group of the optimal parameter can also be set up by repeating this several times.
[0105] Next, two or more forecasts-ed for deciding the coefficient of color processing at the forecast-ed preparation process of S83 are set up. Although it is dependent on the determination method of the color processing ARUKO rhythm to be used and its coefficient, a setup of this forecast-ed shall determine previously the coefficient of the 1-dimensional tables 102-104 here, and, next, shall determine the coefficient of the matrix masking section 105. In this case, in order to decide the coefficient of the 1-dimensional tables 102-104, it is L* in a gray scale, a* =b* =0 [i.e.,]. The forecast-ed which is changing equally from zero to 100 is set up. It will be satisfactory if width of face of the step is made about into 100/256 when using a 8-bit table. Moreover, if it is the premise of wanting to make the color difference small equally by the color space in order to decide the coefficient of the matrix masking section 105, it is L* a* b*. Lattice point data, for example, the lattice point data of ten intervals, are set up as a forecast-ed. You may add the color, as long as there are colors of wanting to make especially the color difference small, such as people's complexion.
[0106] Next, prediction is performed at the forecast calculation process of S84 about two or more forecasts-ed set up at the forecast-ed preparation process of S83. Since it is completely the same as that of the method explained by drawing 1 , the method is omitted. The gray scale and L* a*b* which are a forecast-ed by this The forecast in the RGB color space to lattice point data is obtained.
[0107] Next, a data pair required in order to decide the coefficient of color processing is elected from the data pair of

two or more forecasts-ed and a forecast obtained at the process to S84 at the data election process for color processing coefficient determination of S85. The criteria of election are whether the forecast of a RGB color space is contained in the range treated by color processing of this system. That is, usually, the data of a RGB color space are a gray scale and L* a* b*, although it can express with the unit of a reflection factor. The data which the forecast of the RGB color space of lattice point data has for less than 0 and 100% may be contained. What is necessary is to remove those data and just to elect the data pair by which the forecast of a RGB color space is contained in 0 to 100% of range, since those data are unnecessary as data for color processing coefficient determination.
[0108] Next, the coefficient for actual color processing is determined at the color processing coefficient determination process of S86. First, the coefficient of the 1-dimensional tables 102-104 is determined using the data of a gray scale. Here, the 1-dimensional tables 102-104 shall change the data of the RGB color space proportional to a reflection factor into the data of the R'G'B' color space which makes lightness a unit. The coefficient of the 1-dimensional tables 102-104 corresponding to each signal component of R, G, and B is the value of the forecast of R, or G or B to a vertical axis in a horizontal axis L* A value is taken, the data pair of gray scale is plotted, the transform function from a RGB color space to a R'G'B' color space can be defined by approximating by the polygonal line between plots, and it can be determined by quantizing this transform function.
[0109] Next, it is the coefficient of the matrix masking section 105 L* a* b* It determines using lattice point data. L* a* b* The forecast of the RGB color space corresponding to lattice point data It changes into the data of a R'G'B' color space using the 1-dimensional tables 102-104 decided previously. L* a* b* of the color picture inputted by considering the data of the R'G'B' color space as the input of the matrix masking section 105 By calculating the data of a color space recursively as a target of an output using a least-squares method The coefficient of the matrix masking section 105 can be determined.
[0110] At the last, the precision of color processing is checked at the color processing check process of S87. It checks checking the precision of color processing and is L* a* b* of fading. It means investigating what the data of L*'a*'b*' color space which is an output after color processing have become to the data of a color space. Therefore, arbitrary color L* a* b* to check Consider as a forecast-ed and the data of the RGB color space which is the output of a color scanner 101 are predicted. It is changed into the data of a R'G'B' color space using the 1-dimensional tables 102-104, and it changes into the data of an L*'a*'b*' color space by the matrix masking section 105 further, and is L* a* b*. What is necessary is just to search for the color difference with the data in a color space. It is possible to check the data of arbitrary RGB color spaces for the same thing as a starting point. At this time, it is L* a* b* of the color picture given to a color scanner 101 by making the data of arbitrary RGB color spaces into a forecast-ed. What is necessary is to predict the data of a color space and just to search for the color difference of what changed the data of a RGB color space into L*'a*' b*' using the 1-dimensional tables 102-104 and the matrix king section 105.
[0111] Drawing 9 is the block diagram showing the 2nd example of the system which applies the color transfer-characteristics prediction method of this invention. As for a 3-dimensional table, and 112-115, 111 are [a 1-dimensional table and 116] color printers among drawing. Here, how to be on calculation and to check the precision of the method of determining the coefficient of color processing using the color transfer-characteristics prediction method of this invention, and its processing is explained, using a color printer 116 as a color picture output unit.
[0112] In the system shown in drawing 9 , the data of a color picture which should be recorded are given to the 3-dimensional table 111 as data of L*'a*'b*' color space. The 3-dimensional table 111 changes the data of an L*'a*'b*' color space into the data of the 4-dimensional color space of Y'M'C'K'. In that case, it asks by interpolation processing about the color which is not in a table. L* a* b* of the color picture recorded by the data of L*'a*'b*' color space inputted, and the color printer 116 at this time The data in a color space change so that it may be in agreement if possible.
[0113] The data of the Y'M'C'K' color space outputted from the 3-dimensional table 111 are inputted into the 1-dimensional tables 112-115 for every component. The 1-dimensional each tables 112-115 adjust each component, and output it to a color printer 116 as data of a YMCK color space. the local nonlinearity of the monochrome scale with which the purpose of these 1-dimensional tables 112-115 cannot cope with it on the 3-dimensional table 111 -- an amendment -- they are things
[0114] A color printer 116 receives the data of the YMCK color space outputted from the 1-dimensional each tables 112-115, and records a color picture on a record medium-ed. L* a* b* of the color picture recorded at this time The color picture which reproduced the given color picture data faithfully can be obtained by constituting the coefficient of the 3-dimensional table 111, and the 1-dimensional table 112 so that the value in a color space and the value in L*'a*'b*' color space of the color picture data inputted into the 3-dimensional table 111 may be in agreement.
[0115] Drawing 10 is a flow chart which shows an example of the color processing coefficient determination in the 2nd example of the system which applies the color transfer-characteristics prediction method of this invention, and check

processing. Here, as the gestalt of the 2nd operation of a **** explained as a prediction process, the prediction method which used the data precision function shall be used.

[0116] First, it is L* a* b* of the data of the YMCK color space of an input side, and an output side by outputting a color patch in the various combination of the data of a YMCK color space, and measuring the color at the I/O live-data pair preparation process of S91. A live-data pair with the data of a color space is prepared. Like the case of an above-mentioned color picture input unit, as for the color of various color patches, it is desirable to be uniformly distributed in the color space of an input side, for example, it is ideal to output a color patch in all the combination in every 10% of YMCK etc. However, since a number becomes large too much, even if it thins out using a rectangular table or the data of a YMCK color space change, it is L* a* b* of an output side. By thinning out a field where the data of a color space seldom change, it is practical to output an about 1000-number color patch from several 100. On the contrary, a portion from which the color transfer characteristics of a color printer 116 are changing rapidly may output a color patch at a finer interval. Moreover, it is good to also prepare the device which devises or copes with the heterogeneity of the color patch itself so that these noises may be easy to be removed by the smoothing feature which the color property prediction method has, since the noise by the cause of the heterogeneity within the field of a printer and time instability has ridden on the output signal in the case of the output of a color patch. Since it is the same as that of the case of an above-mentioned color picture input unit, those methods are omitted.

[0117] Next, at the weighting function configuration / parameter setup process of S92, the configuration and parameter of the function of weighting at the time of color transfer-characteristics prediction are set up. For example, it sets up like (30) - (39) formula showing the weighting function equivalent to (9), (11), and (16) - (23) formula below. (Yj, Mj, Cj, and Kj) here The input signal of a forecast-ed or a forecast, The constant of standardization [(Yi, Mi, Ci, and Ki)] of the live data of an input signal, and (Y0, M0, C0 and K0) of input signal space, The output signal of a forecast-ed or a forecast, and (Li, ai and bi) are the constants (Lj, aj, and bj) decide the live data of an output signal, and the constant of standardization of (L0, a0, and b0) of output signal space, and p decides function configurations to be.

[0118]

[Equation 9]

$$
\begin{aligned}
W_{1ij} &= 1/((((Y_i - Y_j)/Y_0)^2 + ((M_i - M_j)/M_0)^2 \\
&\quad +((C_i - C_j)/C_0)^2 + ((K_i - K_j)/K_0)^2)^p + 1) \qquad (30)
\end{aligned}
$$

$$
\begin{aligned}
W_{2ij} &= 1/((((m_{11}(Y_i - Y_j))^2 + (m_{12}(M_i - M_j))^2 \\
&\quad +(m_{13}(C_i - C_j))^2 + (m_{14}(K_i - K_j))^2)/(L_0)^2 \\
&\quad +((m_{21}(Y_i - Y_j))^2 + (m_{22}(M_i - M_j))^2 \\
&\quad +(m_{23}(C_i - C_j))^2 + (m_{24}(K_i - K_j))^2)/(a_0)^2 \\
&\quad +((m_{31}(Y_i - Y_j))^2 + (m_{32}(M_i - M_j))^2 \\
&\quad +(m_{33}(C_i - C_j))^2 + (m_{34}(K_i - K_j))^2)/(b_0)^2)^p + 1) \\
&\qquad (31)
\end{aligned}
$$

[Equation 10]

$$\Delta L_i = L_i' - Li \quad (32)$$
$$\Delta a_i = a_i' - ai \quad (33)$$
$$\Delta b_i = b_i' - bi \quad (34)$$

$$\Delta L_{is} = \left(\sum_{k=1}^{n}(V_{1ik}(L_k' - L_k))\right) / \left(\sum_{k=1}^{n}(V_{1ik})\right) \quad (35)$$
但し、kはi以外

$$\Delta a_{is} = \left(\sum_{k=1}^{n}(V_{1ik}(a_k' - a_k))\right) / \left(\sum_{k=1}^{n}(V_{1ik})\right) \quad (36)$$
但し、kはi以外

$$\Delta b_{is} = \left(\sum_{k=1}^{n}(V_{1ik}(b_k' - b_k))\right) / \left(\sum_{k=1}^{n}(V_{1ik})\right) \quad (37)$$
但し、kはi以外

$$\begin{aligned} W_{3i} = {} & ((|(\Delta L_{is} + \Delta L_i)^2 \times \Delta L_{is} \times \Delta L_i|^{1/4}/L_0 \\ & +|(\Delta a_{is} + \Delta a_i)^2 \times \Delta a_{is} \times \Delta a_i|^{1/4}/a_0 \\ & +|(\Delta b_{is} + \Delta b_i)^2 \times \Delta b_{is} \times \Delta b_i|^{1/4}/b_0)^p + 1) \\ & /((|(\Delta L_{is} - \Delta L_i)^2 \times \Delta L_{is} \times \Delta L_i|^{1/4}/L_0 \\ & +|(\Delta a_{is} - \Delta a_i)^2 \times \Delta a_{is} \times \Delta a_i|^{1/4}/a_0 \\ & +|(\Delta b_{is} - \Delta b_i)^2 \times \Delta b_{is} \times \Delta b_i|^{1/4}/b_0)^p + 1) \end{aligned} \quad (38)$$

$$W_{123ij} = W_{1ij} \times W_{2ij} \times W_{3i} \quad (39)$$

[0119] The parameter of weighting means (Y0, M0, C0, K0), (L0, a0 and b0), and three kinds of constants of p, and the grade of a smoothing feature is adjusted here. As it understands in the configuration of a formula, a smoothing feature is a parameter with which (Y0, M0, C0, K0), and (L0, a0 and b0) become weak, so that, as for p, a value becomes large by a smoothing feature becoming strong, so that a value becomes large. Although it is determined by the grade of the noise of an I/O live-data pair before performing prediction, since it is the same as that of the case of an above-mentioned color picture input unit, these parameters omit the method.
[0120] Next, the weight which is equivalent to (16) - (23) formula at the data precision function weight preparation process of S93, i.e., (32) - (39) formula, to weight W123ij It calculates. Since it is completely the same as that of the method already explained in drawing 3 , the method is omitted here. The data precision function weight to the live-data pair of all I/O is determined by this process.
[0121] Next, two or more forecasts-ed for deciding the coefficient of color processing at the forecast-ed preparation process of S94 are set up. Although it is dependent on the determination method of the color processing ARUKO rhythm to be used and its coefficient, a setup of this forecast-ed shall determine previously the coefficient of the 1-dimensional tables 112-115, next shall determine the coefficient of the 3-dimensional look-up table 111 here. In this case, in order to decide the coefficient of the 1-dimensional tables 112-115 A monochrome scale, i.e., the thing from which Y is changing equally from 0% to 100% at M=C=K=0%, That from which K is changing equally from 0% to

100% at that from which C is changing equally from 0% to 100% at that from which M is changing equally from 0% to 100% at Y=C=K=0%, and Y=M=K=0%, and Y=M=C=0% is set up as a forecast-ed. It will be satisfactory if width of face of the step is made about into 100/256 when using a 8-bit table.

[0122] Moreover, L* a* b* corresponding to the lattice point of the table in order to decide the coefficient of the 3-dimensional table 111 % value of the data of a color space and K corresponding to the color is set up as a forecast-ed. Various methods, such as a method of using the maximum ****, are devised, and the setting method of % value of this K is omitted here, although it is also possible to determine this using the prediction method of this invention.

[0123] Next, prediction is performed at the forecast calculation process of S95 about two or more forecasts-ed set up at the forecast-ed preparation process of S94. The method is L* a* b* to the monochrome scale which is a forecast-ed although it omits since it is completely the same as that of the method explained by drawing 2 . The forecast of a color space, and L* a* b* of the lattice point The forecast of the YMC color space to the data of a color space and % data of K is obtained.

[0124] Next, the coefficient of an actual color processor is determined at the color processing coefficient determination process of S96. First, the coefficient of the 1-dimensional tables 112-115 is determined using the data of a monochrome scale. The coefficient of the 1-dimensional tables 112-115 corresponding to each component of Y, M, C, and K L* a* b* which is the forecast of each monochrome scale at a horizontal axis The color difference value over 0% of chromaticity computed from the value of space % value of Y, M, or C or K is taken along a vertical axis, the data pair of a monochrome scale is plotted, by approximating by the polygonal line, the transform function from a Y'M'C'K' color space to a YMCK color space can be defined between plots, and it can be determined by quantizing this transform function.

[0125] Next, L* a* b* corresponding to the lattice point of the 3-dimensional table 111 for the coefficient of the 3-dimensional table 111 It determines using the data of a color space. For that purpose, what is necessary is to change into the data of a Y'M'C'K' color space and just to let the value be the coefficient of the corresponding lattice point by undoing conversely the 1-dimensional tables 112-115 which determined previously % value of K already determined as % value of the data corresponding to the lattice point of the 3-dimensional table 111, and the YMC color space for which it asked by prediction.

[0126] However, this method is the fundamental method of using, when the data of L*'a*'b*' color space of the lattice point of the 3-dimensional table 111 are in the color gamut which can reproduce a color printer 116. When the data besides the color gamut may be inputted into this system, it is necessary to extend this method. For example, the 1-dimensional tables 112-115 are not created among 0 - 100%. extrapolation -- using -- L* of the lattice point of the 3-dimensional table 111 -- it creating temporarily in the field which covers all the values of 'a*'b*', and, if the same way of determining is adopted using this The data of a Y'M'C'K'Y'M'C'K including outside of that to which some data of color space exceed less than 0% or 100%, i.e., color gamut,' color space can be found. Although this value can be made into the coefficient of the final lattice point after that combining the method of storing to 0 - 100%, the technique usually called Gamut compression, it omits for details.

[0127] The precision of color processing is checked at the color processing coefficient check process of S97 at the last. L* a* b* which checks checking the precision of color processing and is outputted from a color printer 116 to the data of L*'a*'b*' color space of a fading processing input It means investigating what the data of a color space have become. Therefore, change the arbitrary data of an L*'a*'b*' color space to check on the 3-dimensional table 111, and it asks for the data of a Y'M'C'K' color space. The value is changed into the data of a YMCK color space using the 1-dimensional tables 112-115. L* a* b* outputted from a color printer 116 by making the data of a YMCK color space into a forecast-ed What is necessary is to predict the data of a color space and just to search for the color difference with the inputted data of L*'a*'b*' color space.

[0128] Next, the case where a forecast-ed is 1-dimensional data is again explained as an example which applied the gestalt of operation of the 3rd of this invention using drawing 7 and drawing 8 . As mentioned above, drawing 7 shows the color processing in the case of a color scanner input unit, and explained previously the example which decides the coefficients of the matrix masking section 105 to be the 1-dimensional tables 102-104. Here, already, it is decided at once, color transfer characteristics change with the light source of a color scanner input unit, time change of CCD, etc., and these coefficients are explained supposing the case where only the coefficient of the 1-dimensional tables 102-104 is decided on again again in simple.

[0129] Drawing 8 shows the color processing coefficient determination method when not using a data precision function, and also explains a procedure here according to the procedure of drawing 8 supposing the case where a data precision function is not used. The gray-scale patch which has measured lightness beforehand is made to read at the I/O live-data pair preparation process of S81 first, the signal in the RGB color space of an output is measured, and it is lightness L* as live data of an input signal. A live-data pair with the data in the RGB color space as live data of an

output signal is prepared. Although it is dependent on the precision of the prediction for which it asks, about ten number is usually suitable for the interval of gray scale from 10, and when it also determines the coefficient of the matrix masking section 105, it can reduce the number sharply. Since the noise by causes, such as heterogeneity within the field of a color scanner and time instability, has ridden on the output signal at the time of reading, the device from which these noises are easy to be removed by the smoothing feature which the color property prediction method has, the device also in consideration of the heterogeneity of the gray-scale patch itself, etc. are the same as that of an above-mentioned example.

[0130] Next, at the weighting function configuration / parameter setup process of S82, the function configuration and parameter of weighting at the time of color transfer-characteristics prediction are set up. In this case, what is necessary is just to set up the weighting function equivalent to (8) formulas like (40) formulas, since an input is lightness. Here, the input signal of a forecast-ed and (Li) are the constants (Lj) decides the live data of an input signal, and the constant of standardization of (L0) of input signal space, and p decides function configurations to be.

[Equation 11]

$$W_{1ij} = 1/((((L_i - L_j)/L_0)^2)^p + 1) \qquad (40)$$

[0131] It is as having mentioned above that it is what the parameter of weighting means (L0) and two kinds of constants of p, and adjusts the grade of a smoothing feature. In this case, since it assumes having determined the coefficient of the 1-dimensional tables 102-104 and the matrix masking section 105 at once, the parameter of these weighting refers to the parameter then used, and should just determine it.

[0132] Next, at the forecast-ed criteria process of S83, two or more forecasts-ed for deciding the coefficient of the 1-dimensional tables 102-104 are set up. (In this case, gray scale, i.e., lightness L*, What is changing equally from zero to 100 is set up with a forecast-ed.) It will be satisfactory if width of face of the step is made about into 100/256 when using a 8-bit table.

[0133] Next, at the forecast calculation process of S84, prediction is performed about two or more forecasts-ed set up at the front process. the method is entire if the point that processings from S51 to S56 explained in drawing 4 differ from the number of dimension of an input is removed -- it is the same Therefore, explanation is omitted here. The forecast in the RGB color space to the gray scale which is a forecast-ed is obtained at this forecast calculation process.

[0134] Next, at the data election process for color processing coefficient determination of S85, a data pair required in order to decide the coefficient of color processing is elected from the data pair of two or more forecasts-ed and a forecast obtained even at the front process. The criteria of election are whether the forecast in a RGB color space is contained in the range treated with a color processor. That is, usually, although the data of a RGB color space can be expressed with the unit of a reflection factor, the data with which the forecast in the RGB color space of a gray scale exceeds less than 0 and 100% may be contained. Since those data are unnecessary as data for color processing coefficient determination, those data are cut and the forecast in a RGB color space should just elect the data pair included in 0 to 100% of range.

[0135] Next, the coefficient of an actual 1-dimensional table is determined at the color processing coefficient determination process of S86. The 1st purpose of the 1-dimensional tables 102-104 is data of the RGB color space usually proportional to a reflection factor at the following matrix masking section 105 L* a* b* When changing into the data of a color space, it is changing into the data of the R'G'B' color space which makes a unit another unit which is not a reflection factor, for example, concentration, lightness, etc., so that conversion precision may become good. Moreover, the 2nd purpose is changing so that the data of a R'G'B' color space may become the same value, when the difference in the sensitivity of the RGB sensor of a scanner is inputted into a gray by the scanner for an amendment reason. Here, the case where it changes into the unit of lightness is assumed. The coefficient of R, G, and the 1-dimensional tables 102-104 corresponding to B of each is the value of the forecast of R, or G or B to a vertical axis in a horizontal axis Lightness L* A value is taken, the data pair of a gray scale is plotted, the transform function from a RGB color space to a R'G'B' color space can be defined by approximating by the polygonal line between plots, and it can be determined by quantizing this transform function.

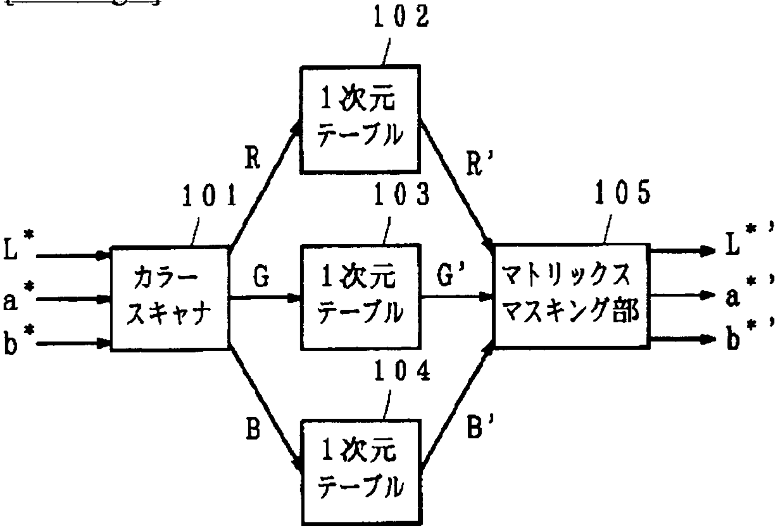
[0136] At the last, the precision of color processing is checked at the color processing coefficient check process of S87. Lightness L* of the scanner input of the gray scale which is color processing to check checking It receives and is L* a* b* after color processing. It means investigating what the output data of a color space have become. Therefore, arbitrary gray scale L* to check It considers as a forecast-ed, the output data of the RGB color space of a scanner are predicted, it is changed into the data of a R'G'B' color space using the 1-dimensional tables 102-104, the matrix masking section 105 is used further, and it is L* a* b*. It changes into the data of a color space and is lightness L*. What is necessary is just to search for a difference.

[0137] As mentioned above, if the color transfer-characteristics prediction method of this invention is used and 1-dimensional data processing is performed when deciding on only the coefficient of a 1-dimensional table again again, realizing using a few live-data pair is possible.
[0138] Although this example explained the case where a data precision function was not used, of course, using a data precision function, by the processing process as shown in drawing 10 , the coefficient of a 1-dimensional table can determine and curing can also be performed.
[0139] In addition, coefficient W1ij of weighting which having made the input signal the forecast-ed and was shown by (40) formulas by making an output signal into a forecast here Although used prediction processing was performed An output signal is made into a forecast-ed and an input signal is made into a forecast-ed. a part of output signal and input signal Conversely, a forecast-ed, If the above-mentioned successive approximation method is used when performing prediction processing by making a part of remaining input signals into a forecast (for example, a case like the color printer shown in drawing 9), it will be W1ij as a coefficient of weighting. It can use and prediction processing can also be performed. Of course, in addition to it, you may use a data precision function.
[0140] Thus, in various cases, the color processing coefficient determination method of this invention can be applied, when determining the coefficient of the color processing about a color picture input unit or a color picture output unit, or when checking the precision of the coefficient of the color processing for which it opted.
[0141]
[Effect of the Invention] According to this invention, the live data of I/O of a color picture I/O device can be processed statistically, and prediction of color transfer characteristics, i.e., prediction of the output signal to arbitrary input signals, and the input signal over arbitrary output signals can be predicted, or a part of remaining input signals can be predicted from a part of arbitrary output signal and input signal so that clearly from the above explanation. By this, color transfer characteristics can be predicted without being dependent on the kind of color picture I/O device, and the time and effort which investigates and models the physical property of equipment can be saved, and it can predict easily only by deciding the parameter of weighting to any color picture I/O devices. Moreover, even if the noise is contained in the live-data pair of the I/O to be used, by determining the parameter of weighting according to the grade of the noise, high predictability can be obtained and the coefficient of color processing of a color picture I/O device can be decided correctly. Furthermore, since the prediction method is easy, it can predict at high speed and there are various effects -- the coefficient of color processing of a color picture I/O device can be determined quickly.

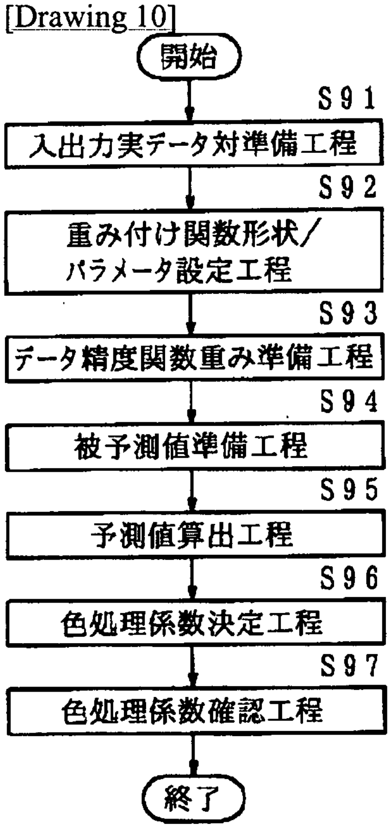
[Translation done.]

DRAWINGS

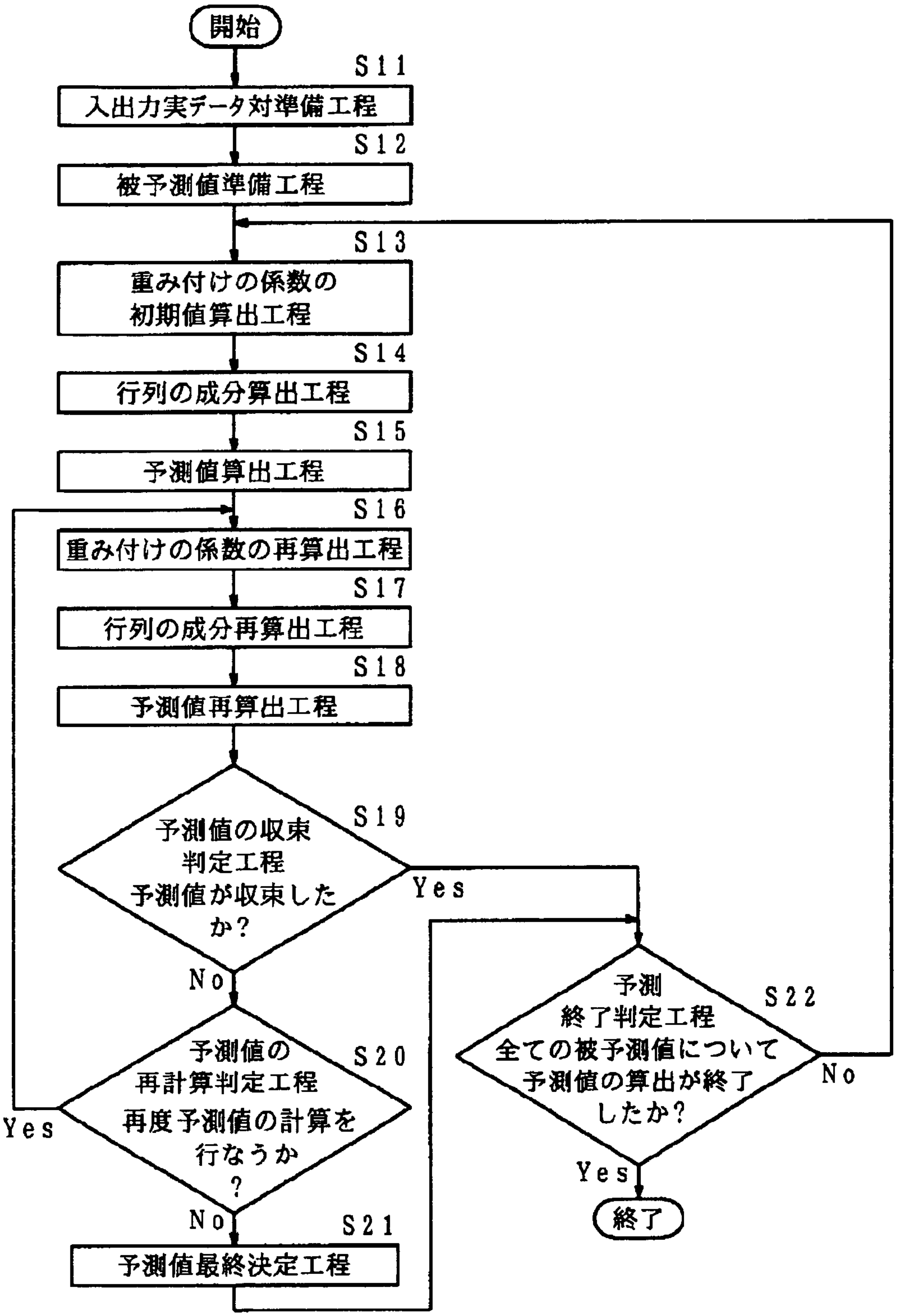
[Drawing 7]



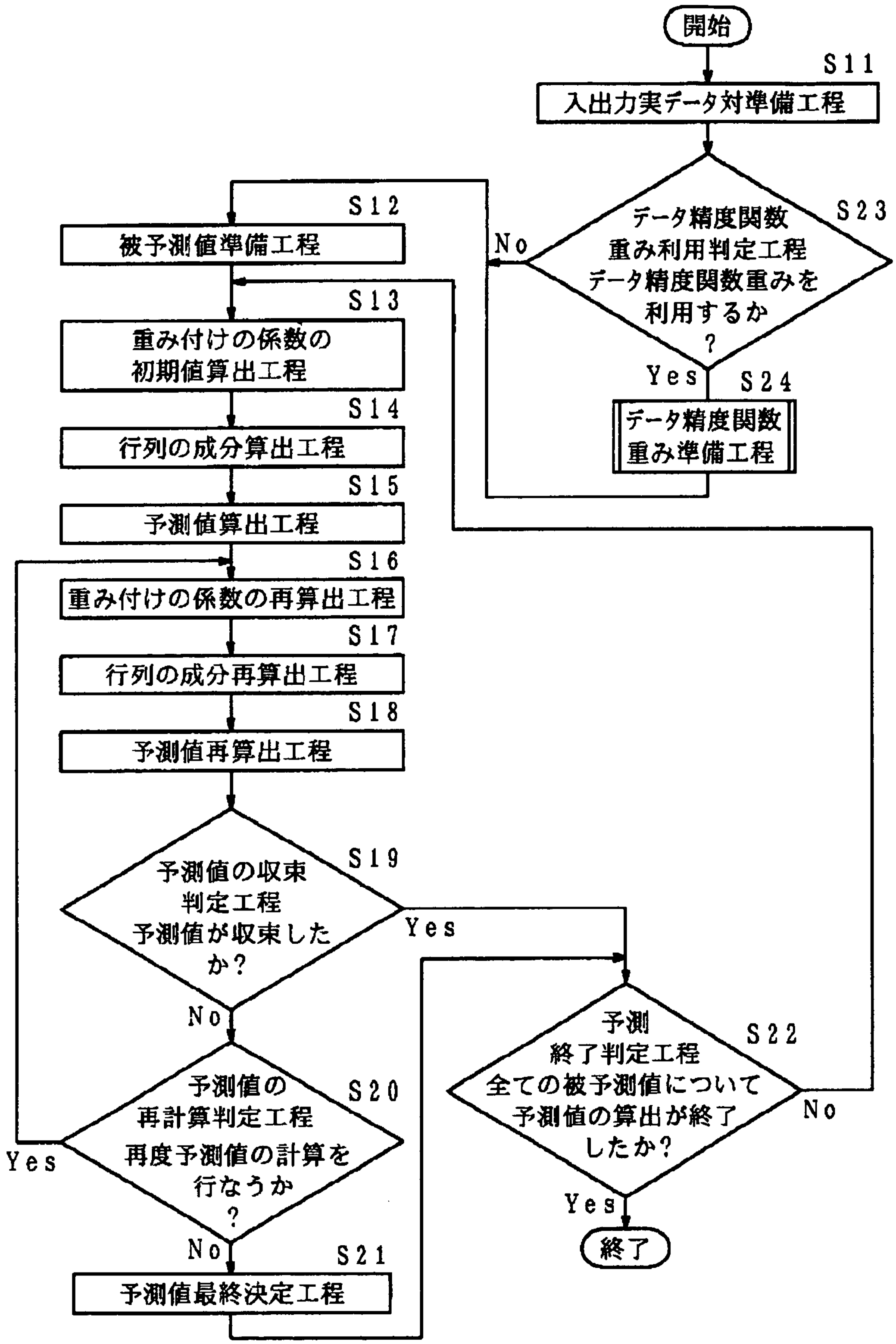
[Drawing 10]



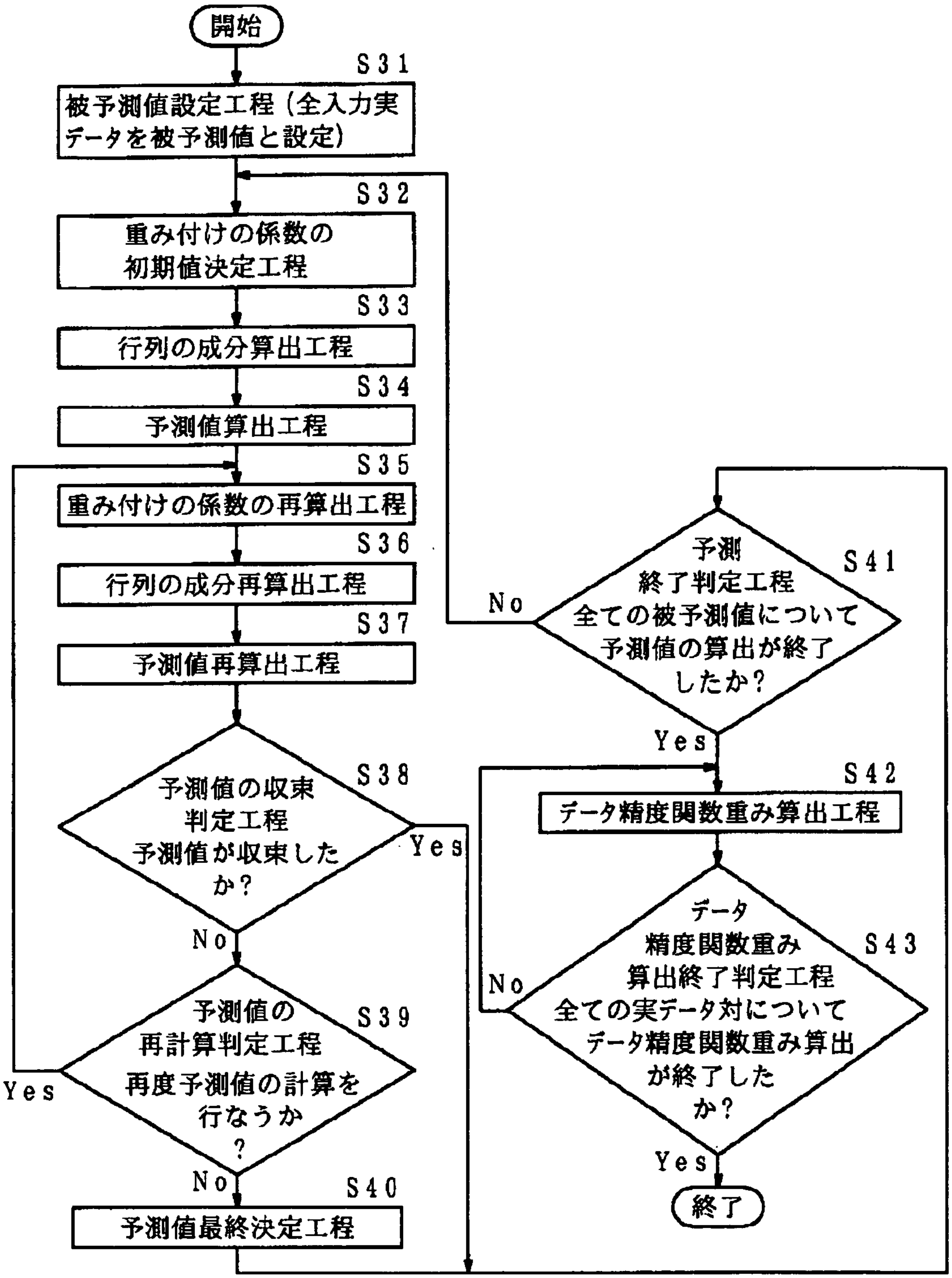
[Drawing 1]


開始
S11
入出力実データ対準備工程
S12
被予測値準備工程
S13
重み付けの係数の
初期値算出工程
S14
行列の成分算出工程
S15
予測値算出工程
S16
重み付けの係数の再算出工程
S17
行列の成分再算出工程
S18
予測値再算出工程
S19
予測値の収束
判定工程
予測値が収束した
か？
Yes
No
S20
予測値の
再計算判定工程
再度予測値の計算を
行なうか
？
Yes
No
S21
予測値最終決定工程
S22
予測
終了判定工程
全ての被予測値について
予測値の算出が終了
したか？
No
Yes
終了

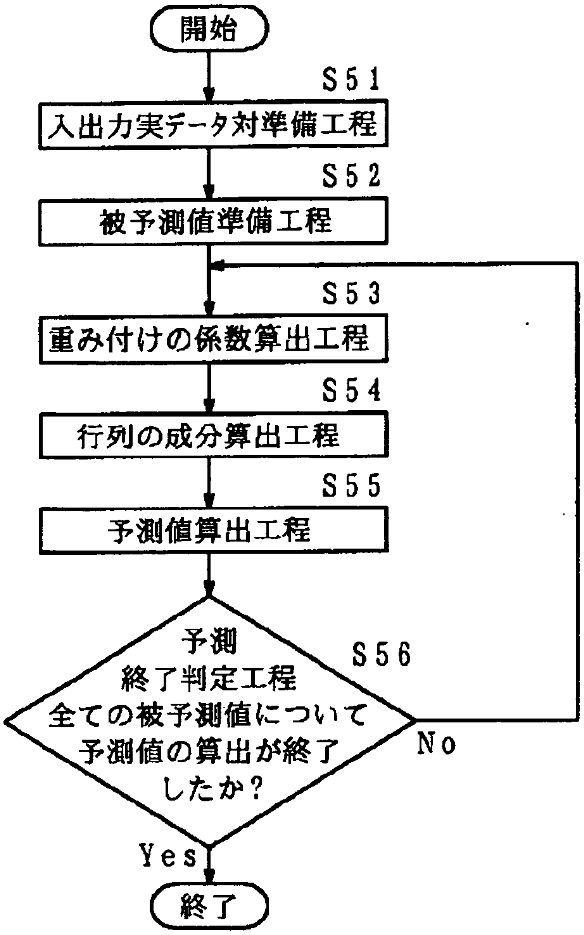
[Drawing 2]


開始
S11
入出力実データ対準備工程
S23
データ精度関数
重み利用判定工程
データ精度関数重みを
利用するか
?
No
Yes
S24
データ精度関数
重み準備工程
S12
被予測値準備工程
S13
重み付けの係数の
初期値算出工程
S14
行列の成分算出工程
S15
予測値算出工程
S16
重み付けの係数の再算出工程
S17
行列の成分再算出工程
S18
予測値再算出工程
S19
予測値の収束
判定工程
予測値が収束した
か?
Yes
No
S20
予測値の
再計算判定工程
再度予測値の計算を
行なうか
?
Yes
No
S21
予測値最終決定工程
S22
予測
終了判定工程
全ての被予測値について
予測値の算出が終了
したか?
No
Yes
終了

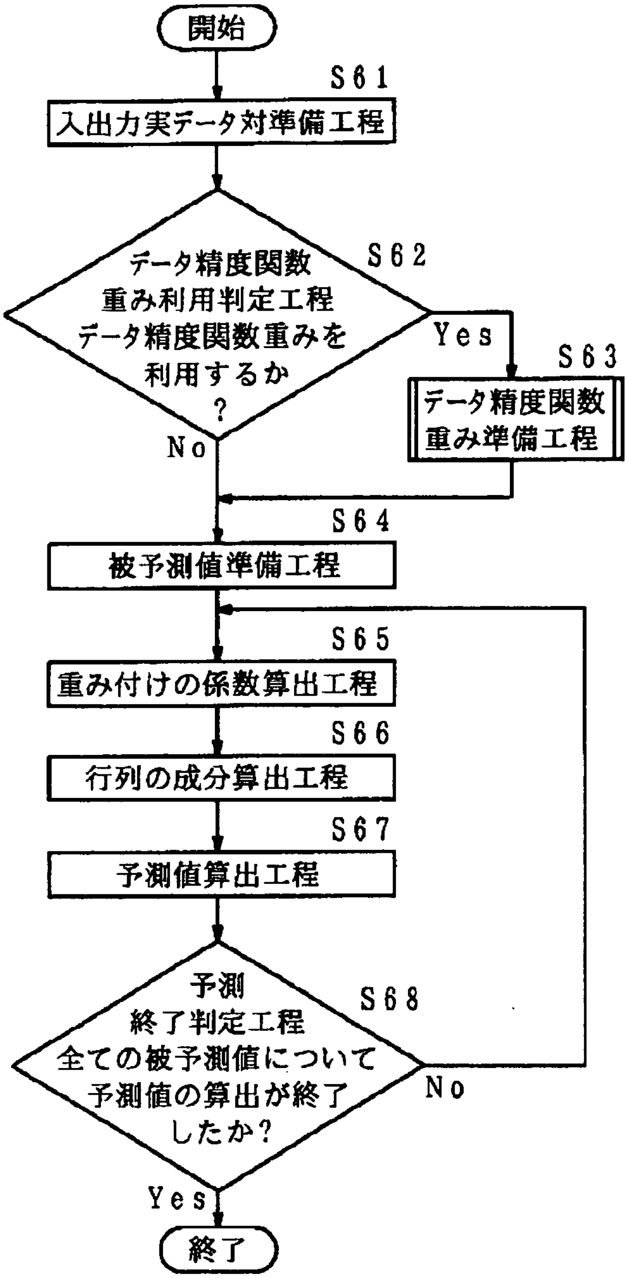
[Drawing 3]


開始
S31
被予測値設定工程（全入力実データを被予測値と設定）
S32
重み付けの係数の初期値決定工程
S33
行列の成分算出工程
S34
予測値算出工程
S35
重み付けの係数の再算出工程
S36
行列の成分再算出工程
S37
予測値再算出工程
S38
予測値の収束判定工程
予測値が収束したか？
Yes
No
S39
予測値の再計算判定工程
再度予測値の計算を行なうか？
Yes
No
S40
予測値最終決定工程
S41
予測終了判定工程
全ての被予測値について予測値の算出が終了したか？
No
Yes
S42
データ精度関数重み算出工程
S43
データ精度関数重み算出終了判定工程
全ての実データ対についてデータ精度関数重み算出が終了したか？
No
Yes
終了

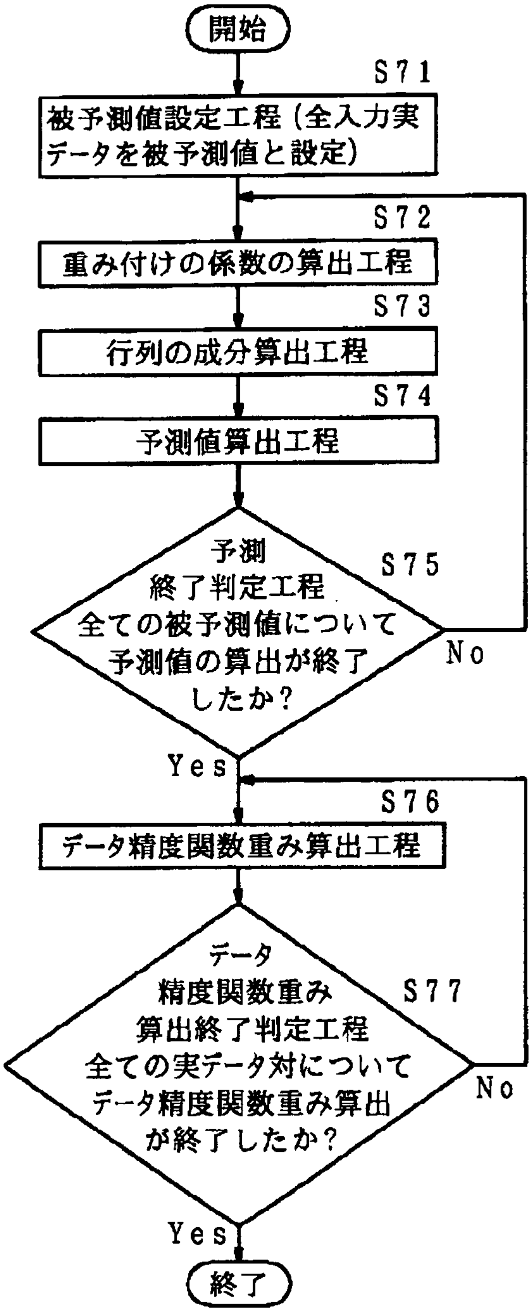
[Drawing 4]


開始
S51
入出力実データ対準備工程
S52
被予測値準備工程
S53
重み付けの係数算出工程
S54
行列の成分算出工程
S55
予測値算出工程
予測
終了判定工程
全ての被予測値について
予測値の算出が終了
したか？
S56
No
Yes
終了

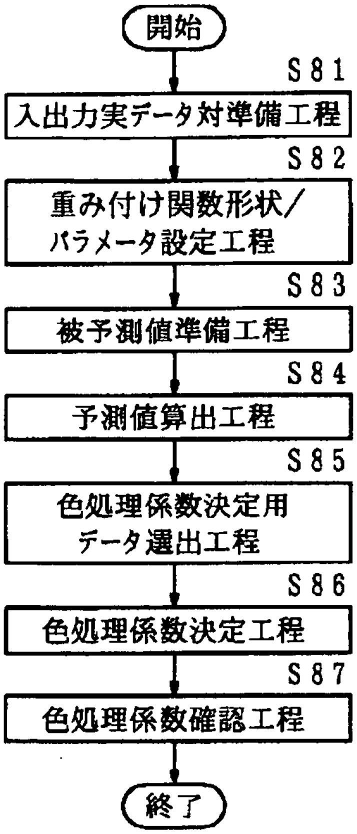
[Drawing 5]


開始
S61
入出力実データ対準備工程
S62
データ精度関数
重み利用判定工程
データ精度関数重みを
利用するか
？
Yes
S63
データ精度関数
重み準備工程
No
S64
被予測値準備工程
S65
重み付けの係数算出工程
S66
行列の成分算出工程
S67
予測値算出工程
予測
終了判定工程
全ての被予測値について
予測値の算出が終了
したか？
S68
No
Yes
終了

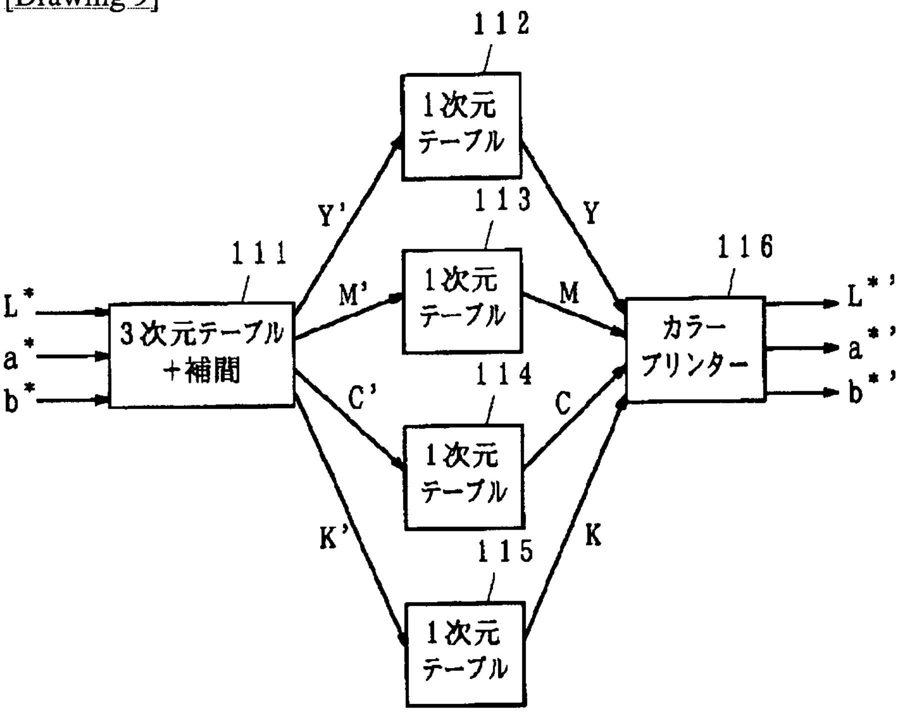
[Drawing 6]


開始
S71
被予測値設定工程（全入力実データを被予測値と設定）
S72
重み付けの係数の算出工程
S73
行列の成分算出工程
S74
予測値算出工程
予測
終了判定工程
全ての被予測値について
予測値の算出が終了
したか？
S75
No
Yes
S76
データ精度関数重み算出工程
データ
精度関数重み
算出終了判定工程
全ての実データ対について
データ精度関数重み算出
が終了したか？
S77
No
Yes
終了

[Drawing 8]



[Drawing 9]



[Translation done.]